THE TELEGRAPHIC JOURNAL AND

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THE DISTRIBUTION OF ELECTRICITY.

LAST week we had an opportunity of privately inspecting the apparatus of the National Company for the distribution of electricity which is now being employed for lighting several of the underground stations on the Metropolitan Railway. The main features in the installation are the "secondary generators" or induction coils of Messrs. Gaulard & Gibbs, which have been very fully discussed in our former articles and also in our correspondence columns. We have never disputed the fact that these apparatus will do a great deal of that which is claimed for them, but, from several points of view, we have had grave doubts as to their general utility. Not the least important matter to be definitely solved in connection with the employment of "secondary generators" is the loss which takes place in the conversion of the electricity from one state to another. On this depends, to a great extent, the success or failure of Messrs. Gaulard & Gibbs' scheme. The cost of the apparatus will form, in our opinion, an item which has perhaps not yet had so much consideration as it requires. Our readers are, however, familiar with the views we have hitherto expressed on the "secondary generator" system. That the lighting of the stations on the Metropolitan Railway is so far successfully accomplished we are pleased to record, and we congratulate M. Gaulard on the results of his perseverance. For technical details of the installation we refer to our other columns.

ELECTRIC LIGHT MACHINERY.

THE prominence which the electric light industry has been the means of giving to many engine builders has been considerable; in many instances it has afforded an opportunity for comparatively obscure names to come conspicuously to the front.

Many of the old-established firms who now figure so prominently in connection with electric light machinery have not perhaps needed a stimulus, inasmuch as their reputations had become too firmly established to require further notice. We think, however, that the demands of electric lighting have been such as to necessitate considerable improvements being made in the efficiency of the engines, both as regards their uniformity of running and their economy. These improvements, although the result of a particular demand, are still improvements which are highly advantageous under any circumstances, although the latter may not have been such as to originate the changes which have taken place. For uniformity of movement and for freedom of running continuously at a high speed and for a long period, the engines now supplied by our best English firms are unequalled in any foreign country. The duty, also, of which the engines are capable has now reached a very high pitch, and in this respect there is but little room for improvement, although the value of the actual loss in the energy obtained from the combustion of coal is a quantity which shows that the most modern engine is very far from being a perfect machine.

To a great extent, the progress which the electric light, for general use, can make in this country must be governed by the economy of the system, and any great stride made towards effecting a saving in the use of fuel must make itself strongly felt in this direction. In America, where the electric light is rapidly making headway, the success is due almost entirely, we believe, to the fact that steam coal is plentiful and cheap, whereas gas coal is scarce, and consequently expensive; an improvement, therefore, in the class of machinery used for driving dynamos is not called for or required.

At the present time the employment of dynamos driven at a high angular velocity is almost universal, although in one or two cases there has been a departure from the general rule. High angular velocities generally mean considerable frictional loss, and also considerable expenditure in lubricants; the more general adoption of machines, which can be driven direct without intermediate gearing, and in which a high linear velocity is obtained, must, therefore, prove economical. The economy effected may, perhaps, not be extraordinarily great, but still when the margin is so small every little saving is of material importance.

The question of gearing is one which up to the present has not received, we think, the attention that it ought. Professor Fleeming Jenkin and Professors Perry and Ayrton, in their "Telpherage" system (to which we shall shortly allude), have paid particular attention to this question, and have introduced certain novel principles of the highest mechanical importance, and which, if generally carried out, would prove highly beneficial.

SNELL'S IMPROVED SWITCHES AND COUPLINGS.

WITH the introduction of large dynamos and the attempts to solve the problem of *cheap* electric lighting with central stations containing very powerful machines, has come also the want of improved fittings to suit the heavy currents generated; and the simplification of testing, when a single station supplies a number of lights over an extensive area also demands careful attention. With this view the fittings described below have been designed, and in the main switch (fig. 1), here illustrated, designed by Mr. C. Scott Snell, the current enters at one terminal and passes by the contact-pieces completely round the circle and out at the other terminal, the number of contact-pieces conveying the current, and, therefore, the number of breaks in the circuit, being of course determined by the strength of the current for which the switch is made. By thus subduing the sparking, it is claimed that the

effect upon the contact-pieces is so reduced that it may be practically disregarded, and the liability of fire is similarly reduced. Another improvement is the short circuiting piece, which, *after* contact has been made by the ring of contact-pieces, "short circuits," as it were, the rest of the switch, and puts large surfaces in contact, so that the heating which might exist if the current ran continually through the other pieces, is prevented. In turning the handle to break the circuit, the "short circuiting piece" is the first to leave its contact, but meanwhile the circuit is still complete through the ring, therefore no flash occurs and clean surfaces always exist here; immediately after this follows the simultaneous breaking of the circuit at each contact-piece in the circle, and supposing their number is seven, the current not only flashes at seven points, but the time occupied in producing any given opening in the circuit is $\frac{1}{7}$th that usually occupied, or, putting it in another form, the movement of $\frac{1}{2}$ an inch of the contact-pieces opens $3\frac{1}{2}$ inches in the circuit.

In the next switch (fig. 2), the same principle is

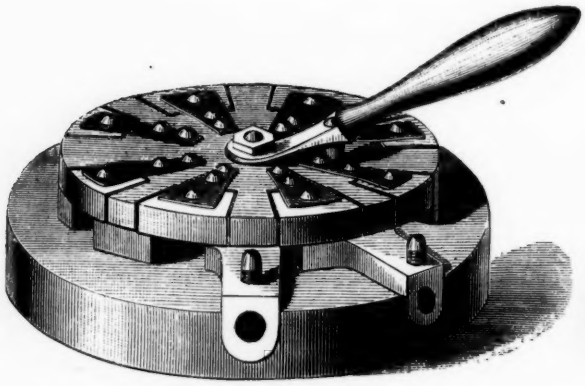


FIG. 1.

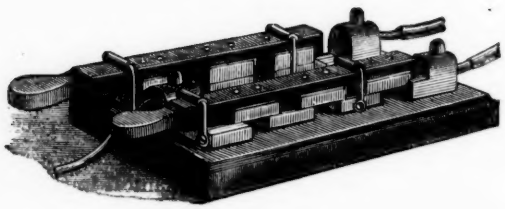


FIG. 2.

adopted of sparking in "series," and this type of apparatus is made up with two or more "warps," as may be necessary. They are exceedingly simple, and have the same advantage as is claimed for the main switch —viz., that in a short movement of the handle, and, therefore, in a short space of time, a large opening is made in the circuit, and the flash so reduced both in intensity and duration as to be practically insignificant.

The mercury switch (fig. 3), the design of Mr. Alfred C. Snell, is used for a variety of purposes where extra good contact is indispensable, where the absence of light whilst switching is desirable, and more especially for testing purposes. The action is plain, the revolution of the barrel either bringing the mercury in contact with the points which enter the barrel, or letting it fall into the recesses made for the purpose, and thus breaking contact. The words "On" and "Off" are stamped on the top and bottom respectively, to indicate whether the circuit is open or closed. A modification of the same switch is used by Mr. Snell in his "street box" for testing purposes, and as a "cut-off," &c. By this means faults are localised with considerable ease, all that is necessary being to cut off any particular main or branch at these junctions and test that particular section, or such sections as it may be desired to include. It is evident that this apparatus may be applied to a variety of other purposes, and it has the merit of "good contact" and general effectiveness. By such arrangements it is probable that electrical mains could be controlled with much more certainty than is now the case.

The cable connections illustrated below (fig. 4) are introduced with a view to secure a simple and thoroughly effective joint. No. 1 consists of a double-cone piece of metal, with the cable arranged as shown in the diagram, so that, whilst splicing is avoided, good contact is maintained, and the cables cannot draw apart, as the ends, being bound with wire, cannot ride over the metal. This is a simple arrangement, but it causes a bulging in the cable which in some positions might be objectionable. In such a case No. 2 is substituted, and this consists of a flat rib or diaphragm of metal, with an edge on the two re-

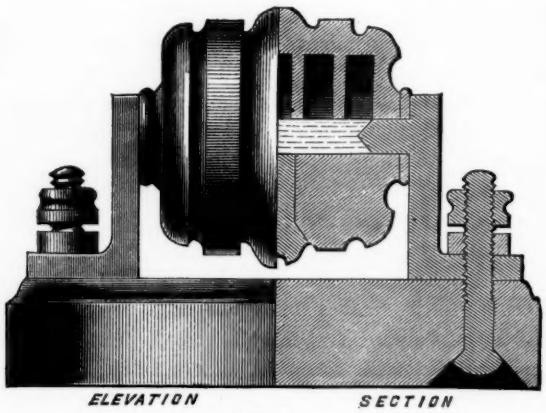


FIG. 3.

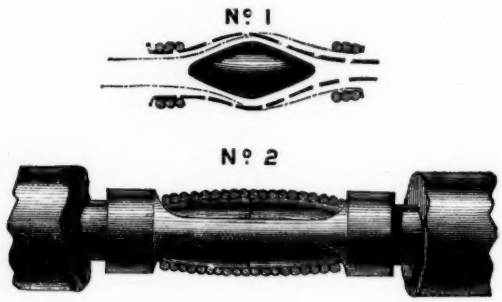


FIG. 4.

spective ends. These ends project into two short tubular end pieces, the whole forming one solid casting.

When the end of a cable is inserted into the tubular end piece, the stands are separated longitudinally into two equal parts by the edge of the diaphragm, and lie, as shown, on each side of it. A similar arrangement is made at the other end of the connector, and binding wire is firmly fastened around the whole, with or without solder on the outside. Large surfaces are in contact, and the whole forms a strong joint mechanically. The sectional area being greater at the joint than at any other part of the cable, the joint is a cool and efficient one electrically.

A New Cable in the North Sea.—Last summer the German Government laid a submarine cable from Emden to the Island of Norderney, in the North Sea, one of the most frequented bathing places of the northern countries. It is intended now to lay another cable, between the coast of Hanover and the Island of Borkum, at the mouth of the River Ems, and about 16 nautical miles from the mainland.

ELECTRICAL TIME BALL APPARATUS FOR HONG KONG.

Designed and Constructed by S. ALFRED VARLEY.

WE have recently had an opportunity of inspecting the above apparatus, which, when it arrives at its destination, and is erected, will be discharged from the Observatory now being established at Hong Kong, under its director, Dr. Doberck.

In our journal of July 15th, 1880, we gave a description, illustrated with woodcuts, of a very complete set of apparatus, designed by Mr. Varley for the Indian Government. This apparatus has since been erected, and gives daily correct time at Fort William, by firing a time gun and dropping a large ball, and also at the port of Calcutta, by dropping a similar time ball erected at that station.

As we gave a very full description of the construction of the apparatus supplied to the Indian Government, and the apparatus to be used at Hong Kong differs from it chiefly in matters of detail, we purpose in this article to confine ourselves to matters of general interest connected with these signals, and to describe what Mr. Varley has aimed to accomplish in his time ball system.

We are indebted to Prof. Airy, the late Astronomer Royal, and Mr. Edwin Clark, for the suggestion, and the first application of electricity to dropping time balls, and among the many useful purposes to which electricity is now being applied, that of giving correct time to our seaport towns, both here and abroad, is perhaps not the least valuable.

The first time ball which was discharged by electricity was erected at the Charing Cross Station, of the late Electric and International Telegraph Company in 1850, and in 1854 a similar time ball was erected by the same company, at their Liverpool telegraph station, which was then under the charge of Mr. S. Alfred Varley.

In first applications of science difficulties are almost invariably encountered, and the discharging with certainty a ball weighing 4 cwt. from a distance of over 200 miles was no exception to this general rule. Some of these difficulties, and the way they were overcome, were described by Mr. Varley in a paper read before the British Association * meeting at Liverpool in 1870. Mr. Varley considers a time ball system should fulfil the following conditions :—

1. The superintendent at the Observatory, from whence the time signal emanates, should be absolutely certain the time ball at the distant station has fallen correctly, and he can only be sure of this by being able to see what takes place at the time ball station when the signal leaves the observatory.

2. As the ball, after it is wound up, hangs for some few minutes on the trigger before 1 h. to prevent its being discharged before the proper time, which sometimes occurs, either from the time wire being accidentally in contact with a telegraph circuit, or from an atmospheric discharge, the trigger should be electrically locked up to the moment just before the arrival of the discharging current.

3. The construction and arrangemeuts should be such that the batteries, the time wire, and other parts of the apparatus, can be tested at any moment with facility, so as to be sure that everything is in proper working order before the time arrives for sending the signal.

The importance of a time ball system fulfilling the above-mentioned conditions is incidentally furnished by the Astronomer Royal's last annual report, from which we quote the following extract :—

† "The Deal time ball has been dropped automatically at 1 h. every day throughout the year, with the exception of five days on which there was failure in the telegraphic connexion, of one day when the ball was accidentally dropped 4 s. too soon by telegraph signals, and of fourteen days when the current was weak and the trigger was released by the attendant without appreciable loss of accuracy."

We believe we are correct in saying, that in all cases, except where the apparatus has been designed by Mr. Varley, time balls are discharged by an electro-magnet, the magnetism of which is produced by the time current. This magnet attracts a soft iron armature and releases a series of levers one after the other, which liberate a bolt on which the ball hangs.

A special feature in Mr. Varley's apparatus is, that he constructs the electric lock on the polarized system ; the trigger of these locks is a jointed soft iron armature which strongly attracts the poles of a soft iron magnet, wrapped with insulated wire, and rendered inductively magnetic by a powerful compound permanent magnet. A spiral spring attached at one end to the armature and at the other to an adjusting screw is so adjusted as to nearly overcome the attractive force existing between the armature and the polarized electro-magnet. The time current when it arrives polarizes the electro-magnet in the opposite direction to that induced by the permanent magnet, and the effect is to release the armature, which is very rapidly pulled away with the full strength of the spring, and to discharge the lock with certainty and great rapidity.

The polarized system was first applied to electric locks in 1859, when Mr. Varley was entrusted by the Astronomer Royal of the Cape of Good Hope, the late Sir Thomas Maclear, with designing the apparatus used for discharging the Port Elizabeth Algoa Bay time ball, 500 miles distant from the Observatory at Cape Town, from whence the time signal emanated.

There is an appreciable interval of time between the arrival of the current at the time ball station and the liberation of the bolt which supports the ball. This arises chiefly from the time occupied by the levers in falling after they have been released and the time occupied in magnetising the electro-magnet. The loss due to this cause has been measured by Mr. Varley by means of a chronograph, and in the Liverpool apparatus, which discharged more rapidly than some of the locks which have been constructed since, the time consumed in magnetizing the electro-magnet and releasing the bolt was found to be $\frac{4}{10}$ths second + a fraction. In the case of the Port Elizabeth electric lock, and in subsequent triggers constructed by Mr. Varley, the loss of time in the apparatus has been reduced to $\frac{1}{10}$th second.

The advantages claimed for the polarized system, apart from its rapidity of action and greater sensitiveness, is that by closing the circuit, as Mr. Varley does in the first instance (when the ball is hanging on the electric lock previous to the arrival of the 1 o'clock current), with say, a — current which increases the attraction between the armature and the soft iron magnet, and making the clock at 1 h. reverse the direction to a + current which reverses the polarity of the soft iron magnet, the trigger is electrically locked up to the time of sending the discharge signal, and as the locking current is stronger than any current likely to be produced by accidental contact with another circuit, the greatest certainty is obtained that the ball does not fall before the circuit is closed by the observatory clock.

We now proceed to describe the apparatus to be used in connection with the Hong Kong time signal.

OBSERVATORY STATION.

The apparatus used at this station consist of a clock, which has been constructed by the well-known firm of Messrs. E. Dent, of Cornhill, and 61, Strand, a reversing commutator and the necessary batteries ; the clock closes a local circuit through the reversing commutator at the beginning of each hour. The reversing commutator (Fig. 1) consists of a polarized relay mounted on a base board, and having two galvanometers on either side.

This polarized relay is constructed of a soft iron magnet mounted on pivots inside a hollow bobbin, wrapped with insulated wire, and having soft iron pro-

* We purpose re-publishing this paper in our next issue.—EDS. ELEC. REV.

† See report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, read at the annual visitation of the Royal Observatory, 1883, June 2.

jecting arms, which work between the poles of permanent magnets. A contact lever is attached to the pivoted soft iron magnet and plays between two insulated contact screws capable of adjustment, and it is so adjusted that the contact lever is held by magnetic attraction against one of the contact screws (which we will call No. 1) when no current is flowing through the insulated wire of the reversing commutator.

The local circuit which is closed by the clock-work includes a battery of a few cells, the left hand galvanometer, and the insulated wire of the reversing commutator. Two other sets of batteries are also employed —one set for locking, and the other for discharging the electric lock; the — pole of the locking battery is connected to the insulated contact No. 1 in the reversing commutator, and the + pole of the discharging battery is connected to No. 2 contact screw of the reversing commutator; the other poles of these batteries are connected to the earth.

The time wire on which the signal is sent is connected through the right-hand galvanometer to the contact lever of the reversing commutator, and excepting during the time the local circuit is closed by the clock, it is always in electrical contact with No. 1 contact screw.

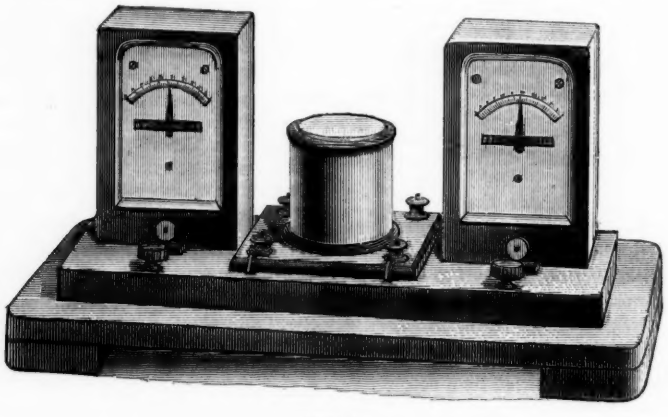


FIG. 1.

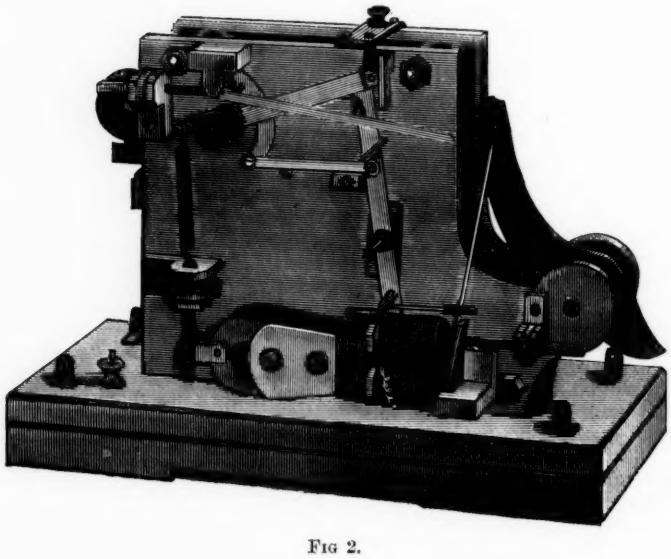


FIG 2.

TIME BALL STATION.

The apparatus at this station consists of the electric lock, fig. 2, which supports the ball after it is wound up prior to the arrival of the time signal, the pneumatic cylinder on which the electric lock is mounted, the time mast carrying the ball-winding gear, &c.

The time wire is disconnected at the time ball station excepting during the time the electric lock is set; the act of setting the trigger completes the circuit through a galvanometer and the insulated wire of the polarised soft iron magnet to the earth. A continuous — current now flows through the time wire and locks the trigger until the clock at the observatory closes the local circuit through the reversing commutator, when the contact lever is immediately attracted over to No. 2 contact screw and a + current is closed through the time wire, the effect of which is to depolarise the soft iron magnet of the electric lock, discharge the ball, and to divide the circuit at the time ball station.

An observer at the observatory station watches the right-hand galvanometer a few minutes before 1 h.; he sees when the trigger is set by the circuit being completed and the needle being permanently deflected towards the word "locked" engraved on the dial.

The moment the clock closes the local circuit at 1 h., he sees the change of direction of the current and the rapid cessation of it consequent on the division of the circuit by the act of discharge; should the ball not fall, or should there be any hanging fire on the part of the apparatus at the time ball station, he also sees this, as also does the attendant at the time ball station, the needles being then permanently deflected. So rapid in practice, however, is the discharge and the consequent division of the circuit, that the galvanometer needle is scarcely deflected at all by the discharging battery.

TESTING ARRANGEMENTS.

Facing the galvanometers, on either side of the reversing commutators, are contact keys; depressing

the left one closes the local circuit (in the same way as the clock does once an hour) and shows the condition

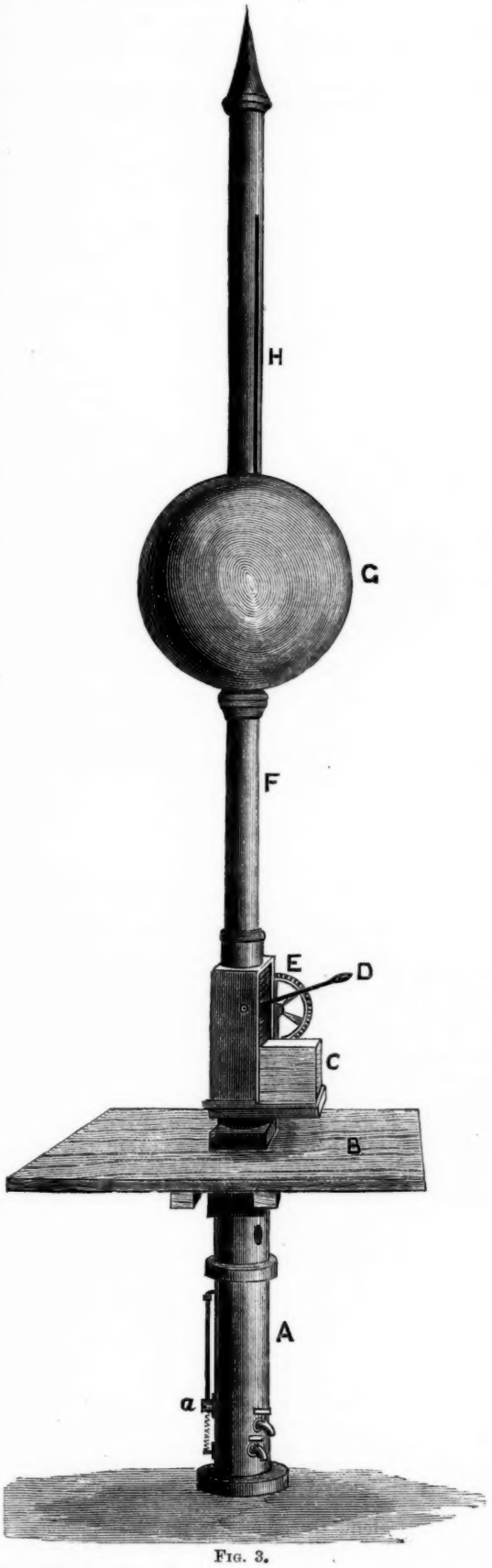


FIG. 3.

of the local battery and whether the reversing commutator is acting properly; depressing the right-hand key connects the time wire to earth, shows the condition of the locking and discharging batteries and the office connections, and, as the time wire between the hours is connected through the galvanometer to the locking battery, any defect of insulation is shown by a deflection of the needle at all times; furthermore, by arranging that the trigger shall be set without winding up the ball, at some fixed hour previous to 1 h., every part of the apparatus can be tested with the greatest facility and any defect remedied before sending the 1 h. signal.

When the distance between the observatory and the time ball station is considerable, so that there is more or less leakage on the line, Mr. Varley prefers not to keep the locking battery permanently connected to the time wire but to divide it by a peg switch, which can be inserted a few minutes before 1 h., or at any time when the insulation of the line is to be tested, and he also prefers to make the trigger record the fact of its discharge by sending a return signal to the observatory from batteries situated at the time ball station.

Fig. 2 represents the electric lock; the drawing shows it just after it has been discharged.

Fig. 3 shows the time ball and its accessories. A is the pneumatic cylinder into which a piston attached to the lower end of the rack (carrying the time ball) enters, producing a cushion of compressed air, which arrests the final descent of the ball without shock or concussion. *a* is a pressure-relieving valve, introduced by Mr. Varley, which enables the amount of compression produced in the cylinder to be regulated, and a greater distinctness in the signal to be obtained, as by its means any rebound on part of the ball can be prevented.

B is the platform or floor inside the time ball station, on which the attendant stands when winding up the ball and setting the lock. C is a wooden box which covers and protects the electric lock. D is a lever for throwing the pinion which works into the rack in and out of gear as required. E is a toothed wheel forming part of the winding gear. F is a steel tube projecting through the roof, and forming part of the mast. G is the time ball, having a girder passing across the centre inside the ball and through the slot cut in the upper portion of the steel mast, H. This girder is attached inside the mast to the upper end of the rack by which the ball is raised.

The diameter of the ball is 6 feet; the total height from the base to the top of the finial, I, is nearly 40 feet.

Although Mr. Varley considers all time balls at seaport towns should be worked on the polarised system with double currents, it must not be supposed that electric locks constructed on the polarised system cannot be worked with single currents. Electric locks constructed in this way work as well as the other form with single currents; they discharge more rapidly and are more sensitive.

The time ball erected on the premises of Messrs. M. F. Dent, Charing Cross, at the corner of Cockspur Street, is on the polarised system, and is worked with single currents supplied through the Postal Telegraph Department.

This time ball, Mr. Varley informs us, has been daily discharged now for 10 years, that during the whole of this time no repairs whatever to the apparatus have been found necessary, and the attendants of Messrs. Dent who have charge of it inform him it has never once failed to discharge and drop the ball, excepting on those rare occasions when no current has been received.

Copper Wire.—The *Ironmonger* reports that an order for 400 tons copper wire has been placed with Wilkes & Co., Bolton & Sons, and Elliott's Metal Company, at an unprecedentedly low price—9d. per lb. Two other contracts are negotiating. One thousand tons of galvanised iron wire for covering will be supplied by Shropshire firms. Six thousand tons of drawn steel wire and rolled rods for the two Transatlantic cables have been divided between two English and one Westphalian firms.

ON THE VARIATION OF THE ECONOMIC CO-EFFICIENT IN DYNAMO-ELECTRIC MACHINES.

IN the course of an examination of a general method of installing a system of electric lighting, by means of incandescence lamps, we employed a factor ϕ, designating it as the *co-efficient of reduction of the luminous rendering* in the machine.*

This co-efficient, continues M. Minet, in *La Lumière Electrique*, was simply the ratio of the work, τ, expended in the entire circuit of lamps to the total energy, T, generated by the machine.

$$\phi = \frac{\tau_1}{T}$$

Let c be the quantity of light given out in normal candles at an expenditure of one kilogrammètre. For the same quantity of energy developed by the machine, the luminous intensity, C, becomes—

$$C = c\phi$$

a formula already established.

If we consider more generally the work expended, τ, in the *total* external circuit, including lamps and conducting wires, the co-efficient, ϕ, takes the name of the *economic co-efficient of the machine.* We get—

$$\phi = \frac{\tau}{T}.$$

whence

$$\tau = \phi T$$

The mechanical rendering of the machine, in the total external circuit, will increase as, ϕ, approximates to unity.

The total energy, T, generated by the machine, is consumed in two distinct ways—the useful work expended in the external circuit, and the work expended in heat in the interior of the machine.

Let t represent this loss of energy

$$T = t + \tau \qquad (1)$$

Let us compare the internal work, t, to the total work generated by the machine.

We can write—

$$\phi_1 = \frac{t}{T}$$

whence

$$t = \phi_1 T.$$

Substituting for t and τ their value in equation (1) we get

$$T = \phi_1 T + \phi T,$$

and eliminating T

$$1 = \phi_1 + \phi.$$

The co-efficient, ϕ_1, may be called *the complement of the economic co-efficient of the machine.*

We will express the work expended in heat, in the external circuit, and in the interior of the machine. We will suppose that the current produced by the machine in a certain instance has only to overcome resistances represented by an external conducting wire.

Let R represent the total resistance, r the resistance of the machine, and I the intensity of the current.

$(R - r)$ will be the resistance of the outer wire. We have

$$T = \frac{R I^2}{g}, \quad t = \frac{r I^2}{g}. \quad \tau = \frac{(R - r) I^2}{g}.$$

And we shall get for the statement of the economic co-efficient, ϕ, and of its complement, ϕ_1,

$$\phi = \frac{R - r}{R} \qquad \phi_1 = \frac{r}{R} \qquad (2)$$

whence

$$\phi = (1 - \phi_1).$$

We shall easily be able to calculate the values of ϕ for all the values of ϕ_1 determined.

Let us substitute for R in formula (2) its value :

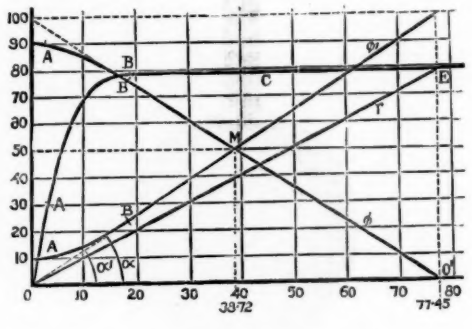
$$R = E I.$$

We shall get, in order to express the term ϕ_1, the new formula

$$\phi_1 = \frac{r}{E} I.$$

For a given machine we see that the complement of the economic co-efficient is in proportion to a constant factor, r, to the intensity of the current, and in inverse ratio to the corresponding electromotive force.

The accompanying figure represents the "characteristic" C of the Gramme machine A, workshop type, at a speed of 720 revolutions. We also show by a curve in the same figure, the variations of ϕ_1, for the machine A, at the speed employed for the determination of the "characteristic." We take for abscissæ the intensities of the current, and for ordinates the values ϕ_1, deduced from equation (3). The numbers inscribed on the axis of y, which gave in units the values of the electromotive force, represent in hundredths those of the subject of study.



We notice that the line $_0$A is essentially straight for slight intensities (from 0 to 3 ampères in the machine taken as example). The electromotive forces are in proportion to the intensities of the current up to an intensity of three ampères.

$$r \frac{I}{E} = \text{constant} = \phi_1.$$

The curve ϕ_1 is therefore parallel to the axis of x as far as A, the point where the line ceases to be straight.

From the point A to the point B (18 ampères), where the "characteristic" becomes parallel to the axis of x, the curve of ϕ_1 can only be expressed by a simple analytical term. We take a few points on it, A, B, sufficient in number to show the form of it, by means of formula (3), taking for the values of E those given by the "characteristic." Starting from point B, the "characteristic" is parallel to the axis of x, the electromotive force is constant.

We get

$$\frac{r}{E} = \text{constant} = K.$$

whence

$$\phi_1 = K I.$$

The curve ϕ_1 becomes a straight line, the prolongation of which passes through the origin.

We can determine its inclination : $tg\ \alpha$.

$$I \operatorname{tang} \alpha = \frac{r}{E} I$$

therefore

$$\operatorname{tang} \alpha = \frac{r}{E}$$

Practically, the currents employed have such an intensity that the magnetic field is saturated. The electromotive forces (constant from point B) are in proportion to the speeds of the machine, and the inclination from the straight is in inverse proportion to the speed.

It is sufficient, therefore, for practical purposes to know the electromotive force, E, at the moment when it becomes constant, at a speed, V, in order to obtain at any speed V_1 whatever, the value of ϕ_1.

* See ELECTRICAL REVIEW for Oct. 27th and Nov. 3rd, 1883.

We shall get

$$\phi_1 = \frac{r\,I}{E} \times \frac{V}{V_1}$$

If V = 1000 revolutions

$$\phi_1 = \frac{r\,I}{E} \times \frac{1000}{V_1}.$$

Let us trace a second curve, ϕ, taking for abscissæ those of the curve of ϕ_1, and for ordinates the values given by the equation

$$\phi = (1 - \phi_1).$$

The curve of ϕ will be symmetrical with the curve of ϕ_1.

It will meet the latter at the point, M, corresponding to an external mechanical rendering of 50 per cent. and to a co-efficient of absorption of force in heat in the interior of the machine, of the same value. The curve of ϕ_1 is limited; the energy engendered is entirely absorbed in heat in the interior of the machine, when the latter is short circuited.

The external work is nil, the economic co-efficient equal to zero, the complement of the economic co-efficient to unity.

Let us draw a straight line, r, the inclination of which is equal to the internal resistance of the machine,

$$\text{tang } \alpha_1 = r.$$

We will draw from the point, E, where the line meets the "characteristic," the ordinate E O'. The prolongation of E O' will meet the curve of ϕ_1, at its extremity; O' will be the point in the curve of ϕ corresponding to an absence of external mechanical work.

In the particular case we are quoting as an example, the inclination of the curve of ϕ_1 is greater than that of r.

These two lines will coincide when the speed of the machine is such that the electromotive forces, for that part of the "characteristic" parallel to the axis of x, are expressed in volts by quantities a hundred times greater than those giving in ohms the internal resistance of the machine.

THE RELATIVE VALUES OF THE ECONOMIC CO-EFFICIENT IN DYNAMO-ELECTRIC MACHINES.

In order to compare the co-efficients, ϕ and ϕ_1 of several machines at a certain speed (say 1,000 revolutions) we must take, for the intensity of circulation in each machine, that which corresponds to the same *density of current* in the wire of the ring.

By density of current we mean the quantity of electricity that passes through the conducting wire, per sectional unit, taking as this unit the section of a wire one millimetre in diameter.

We know by experiment that the machine A, workshop type, can furnish a current 3 ampères in density, in the induced wire without being highly heated.

The current being shunted at half the ring, the intensity of circulation in the total circuit will have a density double that of the wire of the ring.

The magnetic field of the A Gramme machine, with intensities corresponding to densities of 6 ampères, is saturated.

M. Marcel Deprez has determined the "characteristic" of a great number of machines, among which we choose 13 different types indicated in the table. The wires of the induced part had a diameter varying between 0·4 and 4·3 millimetres. For all the intensities of current 6 ampères in density, the magnetic fields had attained their degree of saturation. The complement, ϕ_1, and the co-efficient, ϕ, which we fix upon for each of the machines, correspond therefore to the straight part of the curves, ϕ and ϕ_1.

The intensities of circulation for wires of different sections must be in proportion to the sections of these wires, or to the square of their diameter for the same density of current.

Let 6 ampères represent the intensity corresponding to a wire 1 millimetre in diameter, and we shall get for a wire of given diameter, d,

$$I = 6\,d^2 \qquad (4)$$

The co-efficients, ϕ and ϕ_1, calculated for given intensities given by formula (4), are identical with those that we should have found, if the induced wire of all the machines that we are taking as an example, had a

TABLE.—SPEED 1,000 REVOLUTIONS.

Machines.	Diameter of wire on the ring. d	Current in ampères. $I = 6\,d^2$	Electro-motive forces. E	Internal Resistance. r	Total Resistance. R	External Resistance. $R - r$	Internal work in kilogrammetres. $t = \frac{r\,i^2}{g}$	Total Work. $T = \frac{R\,I^2}{g}$	External Work. $\tau = T - r$	Complement of the economic coefficient ϕ_1	Economic coefficient $\phi = 1 - \phi_1$	Observations.
Gramme for electro-plating .	3mm	54	11	0·097	0·204	0·107	31·20	59·3	28·2	47·50	52·5	
Gramme A *renforcée*	2·6	40·5	54	0·359	1·335	0·976	58·80	218·8	160	26·90	73·1	
„ A workshop type ...	1·8	39·4	86	1·020	4·440	3·420	38·30	166·3	128	23	77	
„ D	1·7	17·3	1360	40	78·5	38·5	1200	2305	1150	51	49	Modified by M. Marcel Deprez.
Siemens D_0	4·3	111	235	0·504	2·120	1·616	622	2602	1980	23·8	76·2	
„ D_1	4	96	160	0·470	1·670	1·200	432	1532	1100	28·1	71·9	
„ D_2	2·5	37·5	94	0·564	2·510	1·946	79·1	352·1	273	22·4	77·6	
„ D_5	1·8	19·4	38	0·649	1·960	1·311	24·4	73·8	464	33·1	66·9	
„ D_6	2	24	55	1·289	2·290	1·001	57·8	132	74·2	56·4	43·6	
Marcel Deprez... ...	1	6	3000	56	500	444	219	1800	1590	11·2	88·8	Type M. D_0 10.
Gramme A *renforcée*.	0·4	0·96	2170	630	2270	1640	58	209	152	27·7	72·3	Modified by M. Marcel Deprez.
„ for electro-plating .	0·4	0·96	460	250	480	230	23	44·15	21·15	52·1	47·9	„
„ inductors *renforcés*	3	54	11·7	0·084	0·217	0·133	24·4	63·1	38·7	38·7	61·3	„

diameter of 1 millimetre and an intensity of circulation of 6 ampères.

For a given machine, the total work developed by the machine, the energy absorbed in its interior, in the external circuit, and consequently, the co-efficients, ϕ and ϕ_1, are the same, whatever may be the diameter of the induced wire, for intensities of circulation in proportion to the sections of the wire wound upon the ring. We will suppose, in order to simplify the reasoning, that the wire wound upon the inductors is the same as the wire on the ring.

Let r be the resistance of the machine, with a wire of 1 millimetre in diameter, I the intensity of circulation, R the total resistance, taken from the electromotive force, E.

$$R = \frac{E}{I}$$

The useful resistance will be $R - r$.

The energies taken into consideration are expressed thus :—

$$T = \frac{R\,I^2}{g} \qquad \tau = \frac{(R - r)\,I^2}{g} \qquad t = \frac{r\,I^2}{g}$$

If we wind on the machine one of the wires with a diameter, d, what will the new resistances be ?

The internal resistance of the machine will become—

$$r_d = \frac{r}{d^4}$$

that is supposing the insulator to occupy the same place ; the error entailed by this hypothesis is very slight, as the table shows. If we cause the intensity to vary in proportion to the square of the diameter in order to have the same density of current, we shall get—

$$I_d = I\,d^2.$$

The work, absorbed in heat by the machine, will become

$$t_d = \frac{r}{d^4} \times \frac{I^2\,d^4}{g} = \frac{r\,I^2}{g} = t.$$

The total work may be expressed :

$$T = E\,I.$$

M. Marcel Deprez has shown that for the same magnetic field (at saturation point in the case in question) the electromotive force varies in inverse ratio to the section of the induced wire, *i.e.*, to the square of the diameter ; we shall again get for

$$E_d = \frac{E}{d^2}$$

whence

$$T_d = \frac{E}{d^2} \times I\,d^2 = E\,I = T.$$

The useful work being equal to the difference between these two we shall also get

$$\tau_d = \tau.$$

A chain of reasoning quite as simple enables us to deduce the total resistance in the modified machine and the useful resistance.

$$R_d = \frac{R}{d^4} \qquad (R - r)\,d = \frac{(R - r)}{d^4}$$

and lastly

$$\phi_d = \phi \qquad \phi_{1d} = \phi_1$$

The eleventh and twelfth columns of the table give the values of ϕ and ϕ_1.

M. Marcel Deprez has modified two Gramme machines—the A *renforcée* and the electro-plating machine.

The wires of the induced parts of the modified machines were very different, as is shown by column 2, from those of the earlier machines ; but, nevertheless, the corresponding co-efficients, $\phi - \phi_1$, have practically the same value.

We may also remark that the M. D. Marcel Deprez machine, type 10, is the one that gives the best result. For 1,000 revolutions, with an intensity of 6 ampères, this machine gives a rendering of 21·2 H.P. in the external circuit, for a total energy of 24 H.P. generated by the machine, with a mechanical rendering, ϕ, of 89 per cent.

At a speed of 1,200 revolutions, with an intensity of circulation of 5 ampères, this same machine would develope a force of 24 H.P. The external circuit would furnish useful work of 22·1 H.P., with a rendering slightly over 92 per cent.

THE DISTRIBUTION OF ELECTRICITY.

IN April last we laid before our readers a description of a system, designed by Messrs. Gaulard & Gibbs, for the distribution of electricity, by means of the so-called "secondary generators," which they were then exhibiting at the Royal Aquarium, Westminster. In this experimental installation, the inventors desired to demonstrate that in conveying a current through a small conductor, electrical energy of varying potential and quantity, might be obtained according to the requirements of each consumer. We contented ourselves with describing the apparatus and the principles on which they were based, and subsequently opened our columns to the discussion between M. Gaulard and his opponents, reserving our final judgment on the interesting question, until a practical application had thrown light on the theories discussed. Two months later we announced the formation of the "National Company for the distribution of Electricity by Secondary Generators, Limited," and shortly afterwards electricians were somewhat surprised by the announcement of a scheme put forward by this company for lighting the banks of the Suez Canal, for a length of 90 miles, by means of a single circuit and four dynamo machines. If we then had reasons to doubt the accuracy of the data on which such a bold project was brought forward, we must do the inventors the justice to announce that they have certainly left but one thing, to which we shall afterwards refer, undone for the purpose of shewing its practicability.

For more than a fortnight the stations of Aldgate, Edgware Road and Notting Hill Gate have been illuminated from a dynamo machine placed at Edgware Road, the current being conveyed by a conductor of 7 No. 16 B.W.G., copper wires passing through the primary wire of the secondary generators placed at each station. The dynamo is a Siemens W° 400-light machine, running at 600 revolutions per minute, and excited by one of the Siemens D type. Part only of this machine is in use at present for supplying a current of 10 ampères at a potential of 1500 volts, or about enough for 250 lights. The resistance of the lead which is taken to Aldgate on the up side of the railway tunnel, thence to Notting Hill Gate on the down side, then back on the up side to Edgware Road, is said to be two ohms per mile, or about 30 ohms for the total distance. The total length of the line is about 14¼ miles. The secondary generator consists of 16 columns, built upon a wooden base, each column containing a bar of iron, which may be exposed to the action of the current circulating around it by raising a brass cylinder which surrounds it. In the apparatus exhibited at the Aquarium the strength of the current was regulated by raising or lowering the iron bar, but this later arrangement, precisely similar to that adopted in ordinary induction coils, seems preferable. The wire on the columns is composed of a centre primary wire No. 8. B.W.G., surrounded by 48 wires, No. 26, B.W.G., each covered with cotton, laid up first in six bunches of eight wires each (see sketch), and these six bunches laid spirally round the large wire and the whole braided with cotton and then boiled in paraffine wax. Two layers of this compound cable, making

about 50 yards are wound on each column. The columns are arranged in four groups of four, and on each group is fixed a commutator. As there are four columns the commutator has eight terminals, to which are attached the eight multiple ends of the fine wires in the cable—two ends for each column. The commutator is so arranged that these ends may be connected in series or parallel, according to the nature of the current required, and each column can be inserted or cut out at will. At Edgware Road 12 columns connected in quantity work the 30 incandescent lamps required for the lighting of the station, and the four remaining columns connected in tension supply the current for two Jablochkoff candles, one in the engine room and one on the bridge.

A "pilot" incandescent lamp is fixed on the secondary generator, by means of which the man in charge of the machine knows when enough of the iron bar is exposed to the action of the primary current by raising the brass cylinder described above.

At Aldgate, two of the columns are not used, as there is only one arc lamp, which requires two columns only, and the remaining twelve serve for the 35 incandescent lamps, said to be of 20 candle power, and three of 40 candle power. At Notting Hill Gate there are 22 incandescent lamps and one arc lamp, and we believe that since our visit of inspection Gower Street has also been illuminated by placing a secondary generator in the primary circuit at that station.

We regret that we cannot furnish any tests taken by ourselves as to the relative amount of current in the primary and secondary circuits. But it is supposed that, as that portion of the machine, sufficient for the 250 lights, is actuating 4 arc and 130 incandescent lamps, over a circuit of more than 14 miles, while the current in the primary circuit is only sufficient for about 250 lamps, that the yield in the secondary circuits is not less than 60 per cent. of the energy produced. It does not follow, however, by any means, that this is the case, as it is quite possible that the machine may be working above its normal power, which is usually considerably below the maximum which can be obtained.

The amount of energy spent in the primary circuit varies according to the work which is performed by the secondary current, and is said to be lowest when the secondary wires are on short circuit—highest when they are disconnected altogether. As this circumstance tends to there being the greatest opposition to change of polarity in the primary circuit, when no use is made of the secondary wires, the latter are automatically short-circuited when not in use.

As this variation in the *apparent* resistance of the primary circuit would necessitate a dynamo of variable electromotive force, M. Gaulard has designed a generator, which may be roughly described as a number of dynamos on a horizontal shaft, each section having its own field-magnets. The terminals of these field-magnets are short-circuited, or opened by an electro-magnet working on a polarised armature. If the apparent resistance of the primary wire were suddenly increased by the opening of one of the secondary circuits, the volt meter would deflect in such a direction as to insert the positive current of a battery working the electro-magnet, which, by attracting the armature, would open the circuit of another of the small dynamos, thereby increasing the electromotive force to the potential required. If, on the contrary, one of the secondary generators was placed on short circuit, and the resistance of the primary circuit thereby reduced, the volt meter would deflect in the opposite direction, and by sending a negative current through the electro-magnet would short-circuit one of the small dynamos and diminish the potential.

Apart from questions of economy, it is evident that numbers of householders are willing to have electric light and power, if they can only do so without the inconveniences of a dynamo and all its accessories. There is nothing in the secondary generator which could not be easily taught to any one quite ignorant of electricity. The daily Press, with the usual indifference to well-known facts, makes public a statement, from which it would appear to the unversed in electrical matters that this system possesses special advantages over others in regard to the loss of energy occasioned by the resistance of the line. M. Gaulard, the engineer to the company, says :—"In this system of distribution a single factor only of the energy increases with the power transmitted, from which it follows that the loss by transport remains constant on a line of a given length, whatever the power transported may be. For instance, on a circuit of 50 miles in length, formed by a conductor of 4 millimetres* diameter, the loss occasioned by overcoming the resistance of the circuit would be, say, 6½ H.P. (the electromotive force employed being 2,000 volts, and the current 10 ampères), whether the force transported and utilised along the circuit be 20 or 1,000 H.P."

We were at first undecided as to the exact meaning of the above extract, which is well calculated to mislead ; but M. Gaulard evidently intends us to understand that if he increases—to any extent—his electromotive force, he inserts in the circuit "secondary generators," the resistances of which would be so arranged as to keep the current strength *always* at 10 ampères. Therefore in the *line* wires the loss by heating of course remains a constant ; but this is also the case with several other systems. Take as an example the "Brush." The loss in the line itself—of a given length—is the same, whether 10, 20, or 40 lamps may be in circuit, and 10, 20, or 40 H.P. utilised.

The current, say, of 10 ampères in a circuit of 10 lamps, with a total electromotive force of 500 volts, would still remain 10 ampères with 20 lamps and 1,000 volts, or 40 lamps and 2,000 volts. In other words, as we increase our electromotive force we increase the resistance of the circuit by adding lamps in such numbers as to keep the current constant. The Gaulard-Gibbs arrangement has, therefore, no advantage in this respect over other well-known systems. M. Gaulard's expression, "loss by transport," is, therefore, incorrect—it should be loss in overcoming resistance for loss by transport includes that from leakage, of which no notice is taken. This, however, will be a serious matter with currents of very high potential.

We should add that for workmanship and elegance the secondary generators we saw leave little to be desired. Those in use are 5 ft. high, the base being 3 ft. 6 in. × 4 ft., and with a current of 15 ampères will yield, we are informed, 15 H.P., or with 20 ampères, 30 H.P.

The steadiness of the light, both arc and incandescent, is remarkable, and we must compliment the engineers of the company on the way in which they have carried out the installation at Edgware Road. The cable in the tunnels was erected by the Henley Telegraph Works Company, and was supplied, we believe, by Messrs. Walter T. Glover & Co., of Manchester.

The one important matter now to be decided is the loss which takes place in the conversion of the electrical energy, and Messrs. Gaulard & Gibbs will meet with the approbation of all electrical engineers by placing the installation on the Metropolitan Railway in the hands of some well-known engineer, whose tests and report would be accepted by the entire profession. We shall return to this matter in our next issue.

REVIEWS.

Annual Report of the Board of Regents of the Smithsonian Institution for the year 1881. Washington: Government Printing Office, 1883.

The subjects dealt with in this report are of the most varied character, embracing every branch of science. The portion devoted to electricity, under the head of "Physics," consists of extracts from foreign journals, and contains no original matter. Under "Heat" the photophone is referred to.

* M. Gaulard takes the resistance of this conductor as 1 ohm per mile.—EDS. ELEC. REV.

Les Telephones. By A. L. TERNANT. Marseilles: Libraire Lafitte, 1, Boulevard du Musée.

This pamphlet (of 64 pages) was originally published in the quarterly *Bulletin de la Société Scientifique et Industrielle de Marseille.* It is a resumé of lectures delivered before the Société, the scope of which was to enlighten the members on the mode of working telephones and erecting lines, &c., and does not pretend therefore to be a complete treatise. Such as the work is, however, it is good, as might be expected from the pen of M. Ternant. The general details involved in the arrangement of offices, the switches, &c., are described and illustrated. The forms of the poles and the general distribution of the wires on the latter are explained. A great many interesting statistics are also given, which add considerably to the utility of the work.

ON THE MEASUREMENT OF ELECTRO-MOTIVE FORCES.

(*Note by* M. E. REYNIER, *presented by* M. TH. DU MONCEL *to the Academie des Sciences.**)

WE know that the electromotive forces of single electrolyte couples (the expression "single electrolyte battery" adopted here, was proposed by the deeply-regretted Alfred Niaudet, to replace the old expression "single liquid battery," of which the sense is too wide, for it would include couples with insoluble salts, or oxides, which are double electrolyte batteries) is very variable: it diminishes by closing the circuit and increases by leaving it at rest; with the same voltaic combination, it is higher as the surface of the positive electrode is greater in relation to that of the negative electrode. Moreover, the *apparent* electromotive forces of these couples change with the form of the battery, the circumstances of the experiment, and the methods of measurement employed.

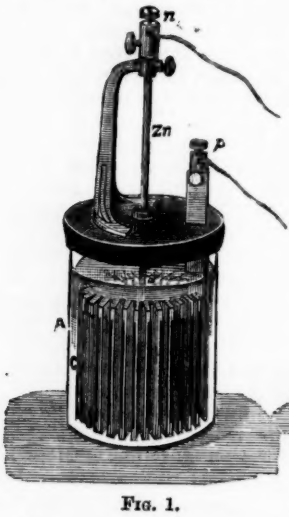


FIG. 1.

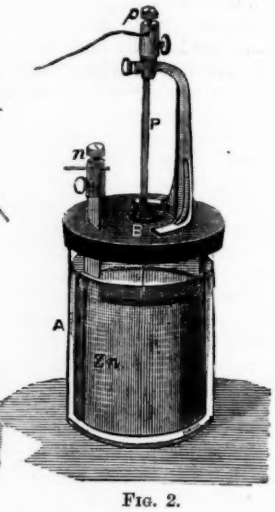


FIG. 2.

Of these various electromotive forces of a couple it is desirable to know the highest and the lowest. I think that I have succeeded in measuring these extremes with certainty by means of the two models which I have the honour to submit to the Academie. Each of these models may be fitted with various positive and negative electrodes and with various liquids.

The *maximum* couple (fig. 1) has the positive electrode Cu, corrugated and perforated, thus presenting an efficacious surface 300 times greater than that of the negative electrode. This consists of a wire 3 mm. in diameter, dipping into the centre of the receptacle. It may be raised out of the liquid and maintained thus by means of a screw, acting upon the collar which guides it. An insulating piece, B, fixed upon the electrode, prevents any leakage by the cover, and serves for a stop when the negative wire is raised.

* *Comptes Rendus.*

This couple, of which the capacity is 800 c.c., has a resistance of from 0·2 to 4 ohms, according to the liquid employed. This resistance is neglected when the total resistance of the galvanometric circuit amounts to several thousand ohms; its electromotive force falls less than one-hundreth part of its value by working for two hours with a current-strength of one milli-ampère. We may therefore consider the battery as constant during the few minutes required for a measurement of potential by the known galvanometrical methods.

The *minimum* couple (fig. 2) has the same external dimensions as the preceding; but it is the negative electrode which has in this the greatest surface. The positive electrode is a wire 0·5 mm. in diameter, of which the submerged surface is less than 1 cq. The resistances of this battery are nearly the same as those of the *maximum* couple.

In order to measure the minimum electromotive force of the couple, we connect the two wires leading to the galvanometer with the two terminals of a short-circuit key; we close the key for several hours, then open it, and immediately take a measurement, which gives a very approximate, if not exact, value of the difference of potential sought The positive electrode of this couple having a very small surface, the products of oxidation formed by the action of the atmosphere are only produced in small quantity; they are completely reduced by short-circuiting, and do not form again sufficiently rapidly to interfere perceptibly with the measurements.

On opening the key, the couple contains no other bodies than those contained according to its definition.

With these two model batteries I have measured the maximum and minimum electromotive forces of a certain number of voltaic combinations with a single electrolyte. The following is a table of the figures obtained:—

Composition of the Battery.			Electromotive force in volts.	
Liquid.	Negative Electrode.	Positive Electrode.	Maximum.	Minimum.
Dilute Sulphuric Acid. Water .. .. 1,000 vol. Monohydrated Sulphuric acid 2 ..	Ordinary zinc	Iridium	....	0·270
	Amalgamated zinc.	„	....	0·289
	Ordinary „	Platinum	....	0·5
	Amalgamated „	„	....	0·361
	Ordinary „	Gold	....	<0·156
	Amalgamated „	„	....	0·128
	Ordinary „	Silver	....	<0·068
	Amalgamated „	„	....	0·108
	Ordinary „	Carbon	....	0·04
	Amalgamated „	„	....	0·226
	Ordinary „	Lead	....	0·144
	Amalgamated „	„	....	0·132
	Ordinary „	Copper	0·94	0·194
	Amalgamated „	„	1·072	0·272
	Ordinary „	Iron	0·429	0·309
	Amalgamated „	„	0·476	0·323
	Amalgamated „	Ordinary zinc ..	....	0·09
	Iron	Copper	0·49 to 0·51	....
Solution of Chloride of Sodium. Water .. .. 1,000 gr. Chloride of Sodium .. 250 „	Ordinary zinc	Iridium	....	0·052
	„	Platinum	....	0·054
	„	Gold	....	<0·028
	„	Carbon	....	<0·040
	„	Silver	....	0·043
	„	Copper	0·78	0·025
	Amalgamated zinc.	„	0·82	....
	Ordinary „	Iron	0·378	0·046
	Amalgamated „	„	0·469	....
	Ordinary „	Lead	0·503	0·044
	Amalgamated „	„	0·52	
	Iron	Copper	0·27 to 0·25	
	Lead	„	0·27 to 0·25	
Chloride of Zinc. Water .. .. 1,000 gr. Chloride of Zinc .. .. 110 „	Ordinary zinc	„	0·85	
	Amalgamated zinc.	„	0·86	
Sulphate of Zinc. Water .. .. 1,000 gr. Sulphate of Zinc .. .. 500 „	Ordinary „	„	0·998	
	Amalgamated „	„	1·04	

From the above data it seems to me that the electromotive force of a single electrolyte couple should be considered as the true electromotive force of the combination; the raising of this force to the maximum would result from the spontaneous addition of products of oxidation formed by the intervention of the atmosphere, the action of these products must not be confounded with the chemical energy produced by the couple properly so called. I would call the attention of physicists who endeavour to establish concurrence between the electromotive forces of batteries and the esults given by thermo-chemistry, to this fact.

OBITUARY.

SIR C. W. SIEMENS, F.R.S.

IT is with the greatest regret that we have to record the demise of that eminent electrician Sir C. William Siemens. Death has been extremely busy during the present year in thinning the ranks of electrical engineers, yet this, the latest addition to the already too long list, is of such a sudden nature that it even now seems scarcely realisable. We learn that Sir William's decease was occasioned by an injury to the heart, brought about by a fall a fortnight previously. Walking home from a scientific meeting on the afternoon of Monday, the 5th inst., he tripped and fell while crossing Hamilton Place. There seemed no reason to fear that rest would not repair the mischief, till on Monday last, quite suddenly, the end came.

Sir Charles William Siemens, F.R.S., was born at Lenthe in Hanover, on the 4th of April, 1823. He received his education at the Gymnasium of Lubeck, the Art School of Madgeburg, and the University of Göttingen. Here he had the advantage of sitting under Wöhler and Himly, and laid the foundation of that knowledge in mechanics, chemistry and physics, which he has ever since so well applied to useful results.

In 1842 he entered as a pupil the Engine Works of Count Stolberg, and there became acquainted with tools and their uses, and with methods of work, thus obtaining that practical knowledge which helps to make the engineer.

In 1843 he visited England for the purpose of introducing a method of gilding and silvering by galvanic deposit, principally the invention of his elder brother, Werner Siemens. Speaking two years ago to the Birmingham and Midland Institute Dr. Siemens, as he was then, gave an interesting and somewhat touching account of the difficulties which not unnaturally beset the young foreign inventor, so ignorant of the language of the country that his first visit was to an "undertaker," under the impression that he was a suitable person to take up and bring out his invention. Thanks to the kindly discrimination of Mr. Elkington, who was able to perceive that certain processes described in some of his own patents could only be carried into effect by the improvements of the Siemenses, he was able to dispose of his invention so far successfully that he was induced in the following year to come back again on a similar errand. He returned immediately to Germany, and in the same year, the brothers invented a differential governor for steam engines. In 1844, he again came to England to patent this invention, and has ever since remained in this country, of which he became a naturalised subject in 1859.

In the same year (1844) was brought out the process of "Anastatic Printing," which invention was due to the two brothers, and was described by Prof. Faraday in a lecture before the Royal Institution in 1845.

About this time his engagements were various: he was at times occupied upon railway works, upon improvements at Hoyle's Calico Printing Works, and upon several other inventions. Between the years 1844-47, he was occupied *inter alia* with the chronometric governor, the regulating action of which results from a differential movement between the engine and a chronometer. Several of these governors are in use at the Royal Observatory, Greenwich, for controlling the motion of transit and recording instruments.

In 1846 was introduced the double cylinder air-pump. in which the two cylinders are so combined that the compressing side of the first or larger cylinder communicates with the suction side of the second and smaller cylinder, whereby the limit of exhaustion is very much extended.

It was in 1847 that he turned his attention to the then new study of the dynamical theory of heat, and also to the use of a regenerator for recovering that portion of the heat which presents itself at the exhaust port of a caloric engine.

The same year he constructed, in the factory of Mr. John Hick, of Bolton, a regenerative engine using superheated steam, the principle attempted to be realised being to recover the latent heat of the steam by restoring to the same for each stroke only such an amount of heat as was expended in the production of mechanical effect. The fuel of the engine was consumed also by air previously heated to a considerable point by means of a regenerator or heat exchanger.

The first engine constructed upon this principle was of four horse-power. An engine of 20 horse-power was placed in the Paris Universal Exhibition of 1857, but not realising altogether the expectations of its designer, another of six horse-power was substituted, made by M. Farcot, of Paris, and was found to work with considerable economy. The use of superheated steam was attended with difficulty, however, and the invention has not been very extensively introduced.

In 1851 he introduced his water-meter, which, both in its original and in a modified form, has been very extensively used both in this country and on the Continent, the number in use being nearly 30,000. They act equally well under all varieties of pressure, and with constant or intermittent supply; they have been tested to register the flow to within 2½ per cent. of the measured quantity, and are manufactured in this country by Messrs. Guest & Chrimes at Rotherham, and in Berlin by Messrs. Siemens & Halske.

Between the years 1856 and 1861, C. W. Siemens, in conjunction with his brother Frederick, worked out the Regenerative Gas Furnace, an invention with which his name will ever be remembered. This furnace is too well known to require a detailed description.

By his arrangement of furnace great economy is attained, great cleanliness in working, and purity of flame: but it has been principally valuable as, owing to the great heat obtainable, it has enabled metallurgical processes to be employed, which cannot be attempted in ordinary furnaces. The temperature is limited theoretically by the point of dissociation, and practically by the resistance to fusion offered by the refractory materials used in its construction.

Ever since the year 1848, he had been interested in telegraph engineering. In 1858 he established, with his brother, Dr. Werner Siemens, and Mr. Halske, of Berlin, and with his brother, Mr. Carl Siemens, then of St. Petersburg and now of London, Siemens, Halske & Co.'s Telegraph Works in London, which are now known as those of Messrs. Siemens Brothers & Co. They have been considerably extended since their formation, and from them telegraph lines have been shipped to various quarters of the globe. The Indo-European telegraph line was constructed by Siemens Brothers in connection with their Berlin house, as also the North China Cable, the Platino-Brazileira Cable, and others. But the most important telegraphic enterprise that Sir C. W. Siemens has been identified with, is that for which the celebrated steamship *Faraday* was built.

This vessel, constructed according to designs of which the conception was due to Sir C. W. Siemens, was employed in 1874 in laying the Direct United States Cable, and succeeded in paying out nearly the entire length in perfect condition; but, as the stormy season had set in, it was deemed advisable to buoy the cable and to defer any further attempts to finish laying it until the summer of 1875. The *Faraday*, therefore, returned to England, and during the winter was refitted, and in June succeeded in completing the work. But a fault was discovered, and another return to England for a piece of cable of sufficient length to repair the damage was found necessary. Early in September the cable was put in complete working order, and on the 15th was opened to the public for the transmission of messages.

The *Faraday* is a peculiar vessel, having stem and stern alike. She was built by Messrs. Mitchell & Co., at Newcastle, and is 360 ft. long, with 52 ft. beam and 36 ft. depth of hold. She has a rudder at each end, and either of them can be rigidly fixed when required. Two screw propellers, driven by a pair of compound

engines, furnish the motive power, and are so placed at a slight angle to one another, that the vessel can turn in her own length when the engines are worked in opposite directions. As the ship can steam backwards or forwards with the same facility, in case a fault is discovered in the cable in the bow compartment, it is not necessary to pass the cable astern before hauling it in, but merely to reverse the motion of the ship, having the stern rudder fixed and making the bow the stern, and a small engine hauls in the cable over the drum just employed to pay it out. The *Faraday* was fitted out with everything necessary for laying the cable, as well as for grappling and recovering lost cable, and a steam launch carried on deck to be used in landing shore ends, was found to be of much service.

The Direct United States Cable, in the successful completion of which Mr. Carl Siemens, Mr. L. Loeffler, and several of the leading *employés* of the firm of Siemens Brothers, so zealously co-operated, was an important step in telegraph engineering.

Since then the firm has successfully laid three more Transatlantic cables, one for a French and two for an American company.

In 1862 he presented to the Institution of Civil Engineers a very elaborate paper "On the Electrical Tests employed during the construction of the Malta and Alexandria Cable, and on insulating and protecting submarine cables."

In 1863 he prepared a paper on "Observations on the Electrical Resistance and Electrification of some Insulating Materials, under pressures up to 300 atmospheres," which was published in the British Association Report for that year. The two main points brought out were that the inductive capacity of gutta-percha is not affected by increased pressure and that of india-rubber is diminished.

On the 14th February, 1867, was read, before the Royal Society, his paper "On the conversion of dynamical into electrical force without the aid of permanent magnetism," which is peculiarly interesting as being the first scientific enunciation in this country of the dynamo-electric principle, upon which the most powerful light-producing machines depend.

Strangely enough, the discovery of the same principle was enunciated at the same meeting of the Society by Sir Charles Wheatstone, while there is, as our readers are well aware, a third claimant in the person of Mr. S. Alfred Varley, who had previously applied for a patent in which the idea was embodied. As regards the Siemens discovery, the originator of the idea was Dr. Werner Siemens, who, on being shown an electrical motor constructed without permanent magnets, immediately saw that a generator without permanent magnets was equally possible. It is just now with the electric light that the name of Siemens is most closely associated in the popular mind. It may be said that if a careful examination were made of the working installations of the electric light, it would be found that a very considerable portion of the real work done had been done by the firm of Siemens Brothers. At the Paris Exhibition, at Munich, at Vienna, and at the Crystal Palace, they were alike conspicuous. Visitors to the just-closed Fisheries Exhibition will remember how large a share of lighting there was effected by Messrs. Siemens. As regards the electrical transmission and conveyance of power, this is a field they have made peculiarly their own. The Berlin electric railway and that at Portrush, are alike the work of one or other branch of the firm, while at his country house near Tunbridge Wells Sir William did much to reduce to human servitude the forces of that mysterious power of which he was so great a master. Not only did electricity perform a large part of the actual work of the farm, sawing wood and pumping water, but it was made to supply in part the place of the sun itself, and assist the growth of plants and fruits.

Another scientific paper presented by him to the Royal Society in 1871, "On Electrical Resistance," was made the Bakerian Lecture for that year. It treats of a method of measuring variation of temperature by variation of electrical resistance; and the new instruments described in this paper, the electrical resistance thermometer and pyrometer, in connection with the differential voltameter, are already being appreciated as valuable auxiliaries in thermometry, and in metallurgical research. These instruments allow of the measurement of temperature without any break, from the lowest attainable degree of cold to a temperature approaching that of the fusion of platinum.

In February, 1876, he read a paper "On the Action of Light on Selenium," before the Royal Institution.

The Society of Arts presented him with its gold medal for his regenerative condenser in the year 1850, and the Institution of Civil Engineers, in the session 1852-53, with its Telford medal.

In 1851 and 1862 he received prize medals of the London Exhibition, and in 1867 was awarded a Grand Prix at the Universal Exhibition of Paris for his regenerative gas furnace and steel process. In 1869 the degree of Doctor of Civil Law, *Honoris causâ*, was conferred upon him by the University of Oxford, and in 1874 he received the Royal Albert medal for his researches on heat, and for his metallurgical processes. In 1875 he received the Bessemer medal of the Iron and Steel Institute "in recognition of the valuable services he has rendered to the iron and steel trades by his important inventions and investigations."

He was appointed first a Commander and subsequently a Dignatario of the Brazilian Order of the Rose. It is not often that life-long exertions like these are recognised by governments, and hence among the few recognitions of this description, this from the Emperor of Brazil must have been of a very pleasing character, as coming, moreover, from a Potentate so qualified to judge of scientific and technical merit.

It will be remembered that the honour of knighthood was conferred on the deceased gentleman early in the present year, and that he was elected as President of the British Association in 1882, and the meeting at Southampton was memorable for the exceedingly practical character of his opening address.

At the meeting of the Institute of Civil Engineers, on Tuesday evening, the president, Mr. Brunlees, spoke as follows:—"It is with the deepest sorrow that I have to inform you of the death of our highly-valued and esteemed member of Council, Sir William Siemens, which took place last night after a short illness, believed to be the result of a fall two weeks ago. Sir William was a man whose power of intellect and whose services in the application of practical science to almost every branch within the range of the profession of the civil engineer were universally appreciated. His fame was world-wide, as it deserved to be, and those who knew Sir William Siemens best will be the most ready to acknowledge that the qualities of his heart were not less conspicuous than those of his intellect. The council are sure that they will best consult the feelings of all present by proposing to adjourn this meeting as a mark of respect to the memory of one who was so greatly honoured and beloved." The following resolution, which had just been passed at a meeting of the council, was then read and adopted as the expression of the views of the members present:—"That this meeting desires to record the deep sense of the loss the institution has sustained by the decease of their eminent and highly-esteemed colleague, Sir William Siemens, and their sincere sympathy with Lady Siemens in her irreparable bereavement."

The Brazilian Submarine Company's Cables.—The s.s. *Scotia*, which went out to repair the St. Vincent-Pernambuco section of this company's cables, has, after being on the ground but a day or two, succeeded in picking up the cable in 1,500 to 1,800 fathoms, and the repairs will be completed, it is expected, within the next few days.

NOTES.

Electric Lighting.—The *Ruaphepha*, sister vessel to the *Tongariro* and *Aorangi*, recently built for the New Zealand Shipping Company's direct service, was launched from the yard of Messrs. John Elder & Company, Fairfield, Govan, on Monday afternoon. Her fittings are of the same high class as her sister-ships, and of course include the electric light.

From Messrs. Caird & Company's shipbuilding yard, Greenock, was launched on Monday a magnificent steamship for the Peninsular and Oriental Steam Navigation Company. The dimensions of the *Valetta* are :—Length, 420 ft. ; breadth, 45 ft. ; and depth, 37 ft. She has been built to the requirements of Lloyd's for the 100 A spar-deck class. The engines are of the most modern description, and the general outfit of the vessel is handsome. The electric light and Binko's patent electric signalling apparatus are to be employed.

The directors of the Mersey Docks and Harbour Board have granted £400 for experiments to be made in connection with the lighting of the approaches to the Mersey by electricity. The results of the experiments are looked forward to with much interest.

On Wednesday week the electric light was brought into use at the Forth Bridge works, South Queensferry, with very satisfactory results. The installations at Inch Garvie and North Queensferry are expected to be ready in a few days.

On Tuesday afternoon the electric light, on the Holmes principle, was tried on the Lancashire and Yorkshire Railway with very satisfactory results. The electric power is generated by a primary battery composed of carbon and zinc plates. This is charged with a chemical of which the composition is for the present kept secret, but to which the inventor has applied the name "oxidone," and it can be adapted for varying periods of from 10 to 40 hours. In other words, if the battery is charged for 40 hours and is in use for only 10 hours per day, four days' work are got out of it. The inventor of the system is Mr. G. C. V. Holmes, C.E., of London ; and Mr. E. Travers Zohrab, C.E., also of London, has produced the necessary mechanical appliances and takes the superintendence of the experiments which are being made. The light has been in use on the Great Northern Railway, we believe, for the last four weeks, in the Pullman dining-room car between London and Leeds ; and it is now, or shortly will be, used on the Great-Eastern line for the Continental mail to Harwich ; on the Midland, for the London and Bradford express ; on the Great Western, for the "Flying Dutchman"; on the London and South-Western, for the London and Bournemouth express ; and on the Manchester, Sheffield and Lincolnshire, for one or more express trains between Manchester and London. The trial carried out on the Lancashire and Yorkshire Railway was effected under the direction of Mr. E. C. Warburton, the company's telegraph engineer. In the first instance the battery, weighing 104 lbs., with its accessories, was placed in the board-room of the company at Hunt's Bank, where the light was shown to the directors ; it was then transferred to a composite carriage forming part of the 3·45 express train to Bradford, of which two compartments were lighted, whilst a third was used for the reception of the battery. This operation was completed in the short space of 25 minutes. The lamps used were Swan's, of the ordinary type, and the light produced was, as to steadiness and brilliancy, all that could be desired. When applied permanently to a train the light is under the control of the guard, who can apply it during the day in tunnels as may be needed ; it may, in fact, be cut off entirely or regulated within a range of from five to 40 candles per carriage. As a rule one lamp of about 10 candle-power is fitted in each compartment. Its cost, according to an estimate made by the company's telegraph engineer, will not exceed one-eighth of a penny per lamp per hour, capital charges being taken into account. Should this estimate prove correct, it would appear that the light can be used with some approach to economy. The residual products, it is said, are capable of being turned to profitable account. With the result of the trial the railway directors were well pleased. When the train reached Manchester at 7·30 on the return journey the light was as good as at the start.

In the Edison installation at "Gatti's," to which we alluded last week, the whole of the fittings were manufactured expressly for the proprietors by Messrs. B. Verity & Sons of Covent Garden, and we understand that it was chiefly through this firm's exertions that the electric lighting of Gatti's establishment was effected.

The "Hammond" Electric Light Company lighted up, on the night of the 12th inst., for the first time, the Derwent Iron and Steel Works, Workington (Messrs. Cammell & Co.). The plant consists of a 16-light "Brush" machine, from which are run 18 lamps of 2,000 C.P., nominal, each. The light was a perfect success in every way. The installation was erected by the Manchester branch of the Hammond Electric Light Company, under the superintendence of Mr. F. D'A. Goold. The new pit of the Wigan Coal and Iron Company has also been supplied with incandescent lamps, and the installation has been running for the last three weeks to the perfect satisfaction of all parties concerned. The plant consists of a Victoria "Incandescent" machine and Swan lamps of 50 C.P., nominal, each, a set of which are about 150 yards down the pit, where they are attached to a circular tube, which can be raised and lowered to meet the requirements of the work, the cable being wound upon a drum in the engine-house. This installation has also been erected under the superintendence of Mr. F. D'A. Goold, district manager of the Manchester branch of the Hammond Electric Light Company.

Messrs. Callender's Bitumen Telegraph Works are lighted throughout with 70 Swan incandescence lamps. The machine employed is a C^5 Bürgin, manufactured by R. E. Crompton & Co.

Telephonic.—A new telephone exchange has been started in South Wales, which groups together Swansea, Cardiff, Newport, and Ebbw Vale, a distance of between 80 and 90 miles. They also join a station at the Mumbles Head.

United Telephone Company.—The Committee of the Stock Exchange has granted quotation to the 20,000 new shares of this company. The 15th inst. was appointed a special settling day for the same securities.

The Tonquin-Hongkong Cable.—We learn that the Telegraph Construction and Maintenance Company will very shortly despatch a ship to submerge this cable, which the French Government has, at last, decided upon laying.

Speed of Working on Submarine Cables.—We are informed that the weights of copper and gutta-percha per nautical mile of the core of the Jay Gould's cables, as given in our last week's number, are not correct, and that these should be taken as follows :—The Jay Gould cables are made with two different cores, A and B. Core A consists of a conductor composed of 10 copper wires, No. 20 (·035), round one copper wire, No. 14 (·083), giving a total weight of 350 lbs. of copper per nautical mile ; and a dielectric of gutta-percha, laid on in several layers, without compound, and weighing 300 lbs. per nautical mile. Core B consists of a conductor composed of 12 copper wires, No. 20 (·035), round one copper wire, No. 12½ (·102), giving a total weight of 450 lbs. of copper per nautical mile ; and a dielectric of gutta-percha, laid on in the same way as core A, but weighing 270 lbs. per nautical mile. Core A was to be laid in depths from 1,000 fathoms and upwards, and core B in depths up to 1,000 fathoms. The lengths of the two Jay Gould's cables are respec-

tively 2,518 and 2,563 nautical miles. The Direct United States cable, laid in 1874-75, has a length of 2,423 nautical miles, and for this cable the core was composed of 11 copper wires, No. 20 (·035), round one copper wire, No. 13 (·095), having a total weight of 400 lbs. of copper per nautical mile, and a dielectric of gutta-percha, weighing 360 lbs. per knot. In some parts, however, these weights were 480 lbs. of copper & 400 lbs. of gutta-percha per nautical mile. The Pouyer Quertier cable, laid in 1879, has a length of 2,395 nautical miles. This cable has a core all through of 350 lbs. of copper and 300 lbs. of gutta-percha per nautical mile. The conductor consists of 10 copper wires, No. 20 (·035), round one copper wire, No. 14 (·083). It would be interesting to know what improvements, if any, Messrs. Siemens Bros. intend making in the Atlantic cables they have now on hand.

The Direct United States Cable Company.—We find the following letter from a shareholder in this company, and the comments thereon, in the money article of Wednesday's *Times*:—The subjoined refers to the Direct United States Cable Company. It is, we believe, true that a new cable would cost much more than £407,000, and if the old cable would last for ever our correspondent's argument would be sound; but that cable will have eventually to be replaced, and that is the purpose for which the reserve fund exists, not for division among the shareholders. Our correspondent is very mistaken in thinking that a new company would give over half a million for an old cable, for the renewal of which a reserve fund of over £300,000 has already been formed:—

"London, *Nov. 15th.*

"Sir,—Since the announcement of the further cable company, inaugurated by Messrs. Gordon Bennett and Mackay, a heavy raid has been made on all existing Atlantic cable property, and the market value of the same has, to the loss of the existing proprietary, been depressed day by day. Without wishing to make light of the possible and probable reduction in the incomes of the existing companies, when next autumn the cables now manufacturing shall be laid and at work, I beg to point out to present shareholders that the raid being made upon their property is overdone, and that they are foolish to allow the tactics of an unscrupulous 'bear' clique, and their own fears of an uncertain future, to make them sacrifice their property at the miserable prices to which the quotations have been forced down.

"I am personally interested in the Direct United States Cable Company, the day's quotation for whose shares is 10⅜ 10⅝, say 10½, or 55 per cent. of the nominal value.

"Now let me put before the public and my fellow-shareholders the position of the company at the present moment.

"The capital consists of 60,710 shares, fully paid up, of £20 each, or £1,214,200, the original cost of the cable, stations, &c., having been £1,278,667.

"The company has a mortgage or debenture debt of £100,000, bringing the total capital up to £1,314,200.

"Against this, on the 30th of June last, the company held a reserve fund, invested in first-class securities, of £315,000, and which, judging by the past half-year's results, may fairly be taken to accumulate to at least £330,000 by the end of December next.

"At to-day's Stock Exchange quotation of £10 10s. only per share, the entire value of the shares represents but a sum of £637,455; deduct from this the reserve fund of £330,000, leaving £307,455, plus £100,000 debentures, say £407,455, or not quite one third of the original cost of the very best of the Atlantic cables yet laid. Now what new cable can be laid for less than fully double this cost? And this is a cable tested by many year's experience, in excellent condition, with a large connextion, earning £160,000 per annum, and, supposing even it were to lose £60,000 per annum in consequence of the coming competition, quite capable of paying a dividend of 7 or 8 per cent. on the present quotation of its shares.

"Would not any newly-formed cable company be ready and willing to buy out all the present shareholders for a lump sum of £500,000, taking over the £100,000 debenture charge, and leaving the present proprietary their reserve of £330,000 for division *pro ratâ*?

"Such an arrangement would give a sum of about £13 5s. per share, while the present price of £10 10s., allowing £5 per share for value of reserve fund, leaves but £5 10s. per share, or £335,000 as total value of cable.

"I think the foregoing facts, vouched for by the company's last balance-sheet of June 30, should deter holders from sacrificing their property."

The following replies have been elicited from others interested in this matter:—

"Temple, November 21,

"Sir,—In the letter of your correspondent 'A Direct Cable Company Shareholder' and in your remarks thereon some important facts are omitted.

"You say 'the correspondent is very mistaken in thinking that a new company would give over half a million for an old cable.' Experience has proved that a good cable that has been at the bottom of the Atlantic 10 years is actually more valuable than a new one. It has stood 10 years' existence, has proved itself a good cable, the insulation is better, and it is positively a better property than a recently laid cable.

"Again, the first electricians of the day are almost, if not absolutely, unanimous in their opinion that the life of a cable is 100 years. It is true that the reserve fund will amount to nearly £335,000 at the end of this year, and until £500,000 is reached it is not intended to put by less than we now do yearly; but that sum being reached, a less sum will be placed to the reserve, and then a much larger sum will be available for dividend. The interest on the reserve fund will not be applied to dividend purposes, but will increase the reserve fund.

"Now financially how do we stand? Since 1877 we have paid a steady uniform dividend of 5 per cent. and have created a reserve fund of £335,000. We shareholders (though expecting shortly 6 per cent.) are quite content with 5 per cent. We and our allies have seven good cables, and if ours failed to-morrow our income goes on just the same. We are working in perfect harmony with Jay Gould & Co. and the Western Union Company of America, and the Dominion Telegraph and other companies. We have had sixpenny and shilling telegrams and have still paid our 5 per cent. One cable at 6d. or 1s. cannot pay; it has been tried and cannot do the work; it would soon be blocked and could not compete with seven cables, where time is everything. In round numbers our net revenue is £106,000, while a 5 per cent. dividend only absorbs £60,710.

"Messrs. Gordon Bennett and Mackay are not starting as a commercial speculation; they profess to be acting philanthropically, but, I imagine, really with the idea of conveying their own press telegrams at their own prices.

"Let timid shareholders sell. We are better without them. I have just increased my holding 50 per cent., and shall continue to buy at present prices.

"G. A."

"*November 21st.*

"Sir,—'A Direct Cable Company Shareholder' omits in his letter which you publish this morning a most important feature touching the security which an investor in this company possesses, and which must be apparent when the facts are stated.

"The division of the Atlantic Cable pool is as follows:—48·825 to Anglo-American Company, 22·500 to American Company (Jay Gould), 16·275 to Direct United States, 12·400 to the French Company—100·000.

"This arrangement terminates in 1927; but if the parties to the pool desire to withdraw in 1902 they can do so.

"Should the Direct Cable be interrupted for twelve months they would get their full share of the pool—viz., 16·275; for the second consecutive year of inter-

ruption, three-quarters of 16·275, or about 12·000; third year, half of 16·275, or about 8·000; fourth year, a quarter of 16·275, or about 4·000.

"Should the cable be broken and mended, and again broken, the arrangements alluded to above comes in force each time.

"A company with this security, and with a reserve fund of £5 per share, and having paid 5 per cent. on £20 for years, cannot be considered dear, and I fail to see but poor returns for any competitor at the present time outside this pool. "M. B. S."

Underground Wires in France.—According to *La Lumière Electrique* the construction of the network of underground telegraphs, undertaken by the Ministry of Posts and Telegraphs, is finished in the eastern part of France. The northern system will not be finished until 1884. The number of kilometres already laid in the whole extent of the country amounts to 4,216 (2,620 statute miles). There still remain some 3,080 kilometres (1,914 statute miles) to be laid down in order to complete the whole system. The lines which are already regularly working, and have been opened to the public service, are those from Paris to Soissons, Paris to Lille, Paris to Nancy, and Paris to Dijon. The same journal also mentions the following regarding these underground lines: As it has been stated in certain papers that the underground lines lately laid down by the Telegraph Administration between Paris, Nancy, Dijon, and Lyons, were in a bad working condition, the Minister of Posts and Telegraphs invited, last week, a certain number of electricians to examine the working of the telegraph instruments on those lines, as well as the system of conductors employed, and the manner of installation of the system. We have assisted at these experiments, and have seen that the Hughes' instruments did their work on those lines as quickly and efficiently as on the overhead wires, and we further noticed with pleasure in the adopted system of conductors, of which there are only three in each cable, but laid up in a particular manner, into which we cannot enter just now, that the effects of induction were nearly imperceptible, and that messages were transmitted with the same facility as on overhead wires. According to what we were told these results are much more satisfactory than those obtained on the Prussian underground lines, which it would appear leave much to wish for. We intend in a future number to say more about the installation of these lines, which, with the adopted system of test boxes and the manner of joining the cables, allows of an easy verification of the state of insulation of the lines as well as of their repairs.

Post-office Telegraph Wires.—A case was heard at Peterborough County Court last week, to try the question whether the Post-office could be compelled to put telegraph wires underground in rural parishes. Thomas Johnston, surveyor of highways in the parish of Walton, Northamptonshire, objected to wires being stretched overhead. The county-court judge held there was no ground for the surveyor's objection as to overhead wires being dangerous, and in a small village this was unreasonable. Mr. Casserley, on behalf of the Postmaster-General, said the case was a test one, which would rule many other similar objections.

Overhead Wires.—A numerous meeting of the vestry of St. Marylebone was held last week at the Court House for the purpose of considering the report of a conference of representatives of various parishes of the Metropolis on the subject of the dangers of the overhead electric wires. Mr. Charles Walker, churchwarden, presided. Two reports were presented, one on behalf of the conference by the committees of St. Marylebone and St. James's, Westminster, and another by the vestry of St. George, Hanover Square. They both detailed what occurred upon the occasion of a deputation to the Local Government Board, when Sir Charles Dilke declared that the Government were of opinion that ample powers already exist by which local authorities can enforce control over all wires placed under or over the streets and thoroughfares of the Metropolis. The united committee adopted a resolution that it was desirable that one local representative body acting for the whole of London should forthwith test the powers of the law on the question. Mr. T. R. Endean, who had acted as chairman of the conference, moved "That this vestry approves the principle of control by local authorities, and resolves that steps should be taken by this vestry to test the question as to the existence of such right of control; but that the mode of procedure shall be determined at a subsequent meeting." Mr. Galsworthy seconded the motion. Mr. Bulnois was perfectly in accord with the mover of the resolution and the committee as to the necessity of this point being settled for the benefit of the public; but he hardly thought it was sufficiently practical, and that it would tend to unnecessary delay. He therefore moved as an amendment to the latter part of the motion, that the subject should be at once referred to the Parliamentary Committee, with power to take counsel's opinion as to the proper course to be pursued, and report thereon to the vestry. Mr. Reed seconded the amendment, which Mr. Endean said he would accept as a rider to the original motion. The motion and amendment were then amalgamated into one resolution, which was adopted. Mr. Greeswell, the Vestry Clerk, was about to read a letter from a gentleman, wishing to detail the particulars of a serious occurrence which had taken place in consequence of the breaking of some overhead wires, but as it was understood there were several others of similar character, it was resolved that they should all be referred to the committee to report thereon.

The Value of Accumulators.—We learn that by an arrangement just concluded in Paris on behalf of the French Metropolitan General Electric Company, Limited, whose prospectus was recently issued, the sum of £30,000—to be increased in certain eventualities to £75,000 before the end of the year—is payable to the Electrical Power Storage Company, Limited, for their interest in the Faure accumulator patents for France and in commutation of all royalties. The latter company has also, it appears, sold the right to use the Faure-Sellon-Volckmar accumulators for the whole of Germany to the Edison Company of Berlin for a considerable sum—over £50,000—in cash and heavy royalties during the currency of the patents, besides a participation in all the subsidiary companies to be formed. In carrying out this arrangement the Berlin company was represented by Messrs. Jacob Landau & Co. and Messrs. Sultzbach Brothers.

The Jablochkoff Electric Lighting Company.—In this case two petitions were presented in the Chancery Division of the High Court of Justice, on Saturday last, before Mr. Justice Pearson, for the winding-up of the company. Mr. Willing, the advertisement contractor, who presented one of them, having been paid his claim, withdrew it. Mr. Pennington, the other petitioner, who held 50 shares, and who had supposed that the capital of the company had been exhausted, had since altered his opinion, and expressed a desire to remain in the company. It was stated that a provisional contract for lighting the district of Marylebone had been obtained by the company, and that there was now a prospect of the necessary capital being obtained for a renewal of the company's operations. The shareholders generally likewise wished the company to go on. His lordship assented to the withdrawal of both petitions.

The Electric-Motor Syndicate, Limited.—Before Vice-Chancellor Sir James Bacon.—Upon the application of shareholders and the company the voluntary winding-up of this company was continued under the supervision of the Court. Mr. Dunham appeared for the petitioners, Mr. Bradford for the company, and Mr. Curtis Price and Mr. D. J. Watson for creditors.

Electric Lighting of Railway Trains.—A correspondent, writing to the *Manchester Guardian*, says: "A paragraph with the above heading appears in your issue of the 18th, in which your readers are informed that experiments are now being tried for lighting railway carriages in which 'accumulators and dynamos are dispensed with, the apparatus being confined to a battery.' The writer adds that the problem is thus 'very much simplified.' A little further on we are told that still other experiments are in progress 'which will do away with the use of expensive chemicals'—do away with the use of a battery—in other words, 'reliance being placed on the utilisation of the energy generated by the movement of the train itself.' As this energy can only be utilised by means of a dynamo, I should be glad to know what we are to understand. Is the battery to supersede the dynamo, or is the dynamo still to be left to do work which, until its invention, batteries were found quite incapable of performing."

The Hammond Electric Light Company.—Remarkable as have been the market fluctuations and artificial values put upon the shares of this company from time to time, says the *Limited Liability Review*, none have been more surprising than the recent rise of the shares from £1 10s., to which they had gradually dropped some few weeks ago, to £3 5s., at which price they are now quoted. * * * Why, it may be asked, have the shares gone up to the price of over £3 after being £1 10s. with a downward tendency? The answer is a simple one to our mind—Stock Exchange manipulations: and we have seen the game played so often that we do not think we are deceived. * * * With these manipulations, however, our general body of readers will have little or no interest. There may, however, be amongst our readers many shareholders in the Hammond Company, and it is to these we say—Embrace the present golden opportunity, for it is never likely to occur again. While it is the interest of the manipulators to force up the market price of the shares, let them purchase yours, for they will assuredly soon find the low level which they would now be at but for market operations. * * * We should not advise shareholders to throw away their shares at 2s. 6d. or 5s. apiece, as the shareholders in some of the best electric light companies are doing; but we do think that the holders of shares, especially those who have already lost heavily by their speculations, should take advantage of present prices and sell their shares. Let it be understood that our advice only extends to those who have the shares to sell, and not to speculators who would sell a bear of the stock. * * * Since writing the above it has been announced that definite arrangements have been made by the Hammond Company for the purchase of the assets and business (?) of the Birmingham and Warwickshire Brush Company, as well as the assets and business of the Ferranti-Thompson and Ince Electric Company, in both of which cases a large number of new Hammond fully-paid £5 shares are to be issued. The effect of this will be to so largely increase the capital of the Hammond Company as to make any chance of dividend upon the shares a question of very far distant date, and the probability is that those interested in the absorbed companies will naturally take the earliest opportunity of selling their Hammond shares before the prices come down. We have not the smallest hesitation in saying that before three months are over the Hammond shares, then £5 paid (for there is a call of £1 5s. nearly due upon them) will not be saleable at £2 per share; and those who now take our advice will then have reason to thank us, as have many of the old holders of Anglo-American Brush.

Telegraph Stores.—The directors of the North Eastern Railway invite tenders for the undermentioned articles, in such quantities as they may require, during the six months ending 30th June, 1884, delivered carriage paid at the company's telegraph stores, at York:—1. Telegraph apparatus; 2. Telegraph wire and line stores. Payments of each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be had on application to Mr. Graves, Telegraph Department, York, and tenders must be sent in to the secretary, at York, sealed and marked "Tender for Telegraph Stores," by noon on the 28th inst.

The late C. F. Varley.—At the meeting of the New York Electrical Society, Friday, Nov. 2nd, the following resolutions on the death of Mr. C. F. Varley, were unanimously adopted:—

Whereas, by the death of Mr. C. F. Varley, the Science of Electricity has lost one of its most devoted disciples; and

Whereas, by reason of his professional connection with the laying of the first Atlantic cables, as well as by his numerous electrical inventions, his name will always be associated with the history of the development of the science of electricity in the nineteenth century; and

Whereas, in view of the foregoing, it is but proper, that we, as a society, organized for the study of the science of which the late Mr. C. F. Varley was so industrious a student and so successful an exponent, should make suitable expression of the sorrow with which the announcement of his death was received by us; therefore, it is

Resolved, that this Society does hereby express its sincere regret at the loss by death of the late Mr. C. F. Varley; and further

Resolved, that a copy of these resolutions be spread on the minutes of this Society; and also

Resolved, that the electrical papers of New York City be requested to publish these resolutions.

The Stabbing of English Workmen in Paris.—The first information received in England regarding the affray between English workmen and French roughs in Paris appears to have been considerably overdrawn. The correspondent of the *Standard* says:—"The Englishmen, after the affray, went into a druggist's, obtained plaister for their wounds, and walked home. No one was taken to the hospital, and no one has been arrested. I have derived the above information from the Central Municipal Police Office."

Electrical Conductors.—Mr. W. H. Preece, F.R.S., will shortly read a paper on "Electrical Conductors," before the Institution of Civil Engineers.

Bradford in Darkness.—We learn that for some reason there was a failure in the supply of gas at Bradford the other night, and the gaslights everywhere were only just sufficient to make "darkness visible." Those who were obliged to light up their places of business had to seek a supply of candles and oil lamps. New and extensive gasworks, costing £150,000, have just been opened in the same town. One of the townships, however, as well as the mills, are about to be supplied with electricity by the Corporation, under the powers recently obtained by them.

The Central News Telegraph Company and Others.—Mr. Grain applied to the Court in reference to the prosecutions instituted by the Central News Company against *Judy* and the *Sportsman* for libelling them by charging them with having published bogus or fictitious telegrams relating to matters of public interest. With respect to the case of *Judy* the ex-Lord Mayor committed the defendants for trial, and in the case of the *Sportsman* the charge was dismissed, but upon the application of the prosecutors they were bound over under the Vexatious Indictments Act to prefer a bill at the present sessions. It had since been ascertained that other libels besides the one that was the subject of prosecution had been published in the *Sportsman*, and he asked the permission of the Court to add counts charging these libels in the indictment to be prepared against the *Sportsman*. The prosecutors had communicated with the conductors of the *Sportsman*, and requested them to send to the office of the Central News

for the purpose of satisfying them that the telegram they referred to had really been received at the Central News; but they took no notice of this communication, and published a similar charge in a subsequent number of the *Sportsman*. Under these circumstances he asked the permission of the Court to include the additional charges of libel in the indictment.—The Recorder doubted whether he had the power to grant the application. It appeared to him that the proper course would be to go before a magistrate and take out a fresh summons.—Mr. Grain said this would involve a great loss of time and expense.—The Recorder said he should not feel justified in granting the application until he had heard what the counsel for the defendant had to say upon the subject, and in the meantime the matter would stand over.

On a New Aperiodic Galvanometer.—By M. G. Le Goarant de Tromelin.—If we add a third magnetic needle to an astatic galvanometer, so that it is below the frame and parallel to the two others, and so that its poles may be opposite to those of the needle above it, we obtain a galvanometer, the sensibility of which is nearly trebled, and which preserves a directive force. We may also reverse the arrangement, making the frame moveable, into which the current arrives by the suspension-wires, and leaving the needles fixed.

The above considerations have led the author to devise an *aperiodic* galvanometer, which has been exhibited at the Vienna Electrical Exhibition. A more perfect model has since been constructed by the firm of Breguet.

In this instrument the six poles are retained, but the poles are formed by three horse-shoe magnets with legs very near together. These three fixed magnets are placed horizontally, one below another, at a distance of 0·005 metre. The frame encloses the two poles of the middle magnet, with play sufficient to permit it to oscillate freely, and obtain a deviation of 20° on each side. The light wire of this small frame is perpendicular to the axis of the magnets, and the current arrives by means of the suspension wire, as in the syphon-recorder of Sir W. Thomson and other analogous frames.

If we place this galvanometer in communication with the two ends of a telephone from which the vibrating plate has been removed, then, in order to make the frame deviate, it is sufficient to let fall upon the pole of the magnet of the telephone a small fragment of iron-filing weighing a few milligrammes. This example will show its sensitiveness.

It is completely aperiodic, *i.e.*, if the two extremities of the galvanometer are connected by a wire of little resistance, the frame having deviated from its position stops at zero without passing it.

If we examine the position of the lines of force with reference to the four sides of the frame, we see that electro-magnetic induction is produced on the four sides of the frame and in the same direction.—*Comptes Rendus.*

The Magnetisation of a Steam Boiler-Injector.—By C. Thouvenot.—The author, as did previously Tommasi, obtains an electro-magnet by passing steam of the pressure of two atmospheres through a copper tube of 1·5 millimetre in diameter coiled round an iron core.—*Weidemann's Beiblätter.*

On a New Condenser.—By H. Schneebeli.—Condensers made by Berthoud, Borel & Co. take in one second $\frac{2}{3000}$, and in five seconds their entire maximum charge. They scarcely show any residues. If charged with three Daniell's, the charges vary per Daniell only from 140·2 to 139·4. If the condenser is charged with a normal Daniell at 20–21° C, its capacity was 140·5, and on introduction into an ice-closet, after 16 to 40 hours, 138·6 to 135·2. If heated again to 20·5° C, after 24–48 hours only 140·3. A change of temperature of 1° C, alters the capacity, therefore, only by 0·075 per cent. The loss of charge in ice in five minutes is only 1 per cent.—*Wiedemann's Beiblätter.*

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Hammond Electric Light and Power Supply Company, Limited.—An agreement dated 10th inst., provides for the transfer of the patents, undertaking, property and effects of the Ferranti Company to this company, in consideration of the allotment of 7,200 fully paid shares in the Hammond Company, of the nominal value of £5 each, and 16,000 fully paid shares to be called B shares. The profits of the Hammond Company will be in future divided as follows: (1.) In payment of 5 per cent. dividend on the ordinary capital; (2.) In payment of 5 per cent. on B capital; (3.) In providing such reserve fund as may be considered necessary, the remainder to be divided rateably between both classes of shareholders. In the event of the profits being sufficient, in three consecutive years, to pay 7½ per cent. per annum dividend, or in the event of dividend at such rate being paid over an average period of five years, on both classes of shares, the deferred shares will cease to be deferred shares, and will rank equally with the ordinary shares. The agreement also stipulates that the Ferranti Company shall use its best endeavours to induce Sir Wm. Thomson to reduce the royalty reserved in his favour by the deeds under which the Ferranti Company hold the Ferranti and Thomson patents to 5 per cent., in lieu of 10 per cent., the sum now payable. Mr. Sebastian Ziani de Ferranti is to be appointed electrician of the Hammond Company for two years certain, at a salary of £500 per annum.

Electric Signal Company, Limited.—The statutory return of this company made up to the 25th of September, was filed on the 19th inst. The nominal capital is £1,500 in £10 shares, 70 of which have been taken up, and in response to a call of £3 per share, the sum of £200 has been paid up thereon, leaving £10 unpaid. Registered office: 7, Bridge Avenue, Hammersmith.

William Elmore, Limited (Electrical Engineers).—The statutory return of this company, made up to the 19th December, was filed on 26th September. The nominal capital is £240,000, in £10 shares. 8,000 deferred and 3,539 preference shares have been taken up, and upon the former £5 per share has been called, and £10 per share upon the latter. The calls paid upon the preference shares amount to £11,949 10s., and upon the deferred shares £80,000 is considered as paid. The calls unpaid amount to £5,745 10s. Registered office: 91, Blackfriars Road.

The business carried on by Shackleton Hallet and William Elmore, of the Electrolytic Company, was purchased by this company upon terms of agreements dated 26th of April last, and filed the following month, the consideration being £10,000 in cash or acceptances of the company, £30,000 in the company's acceptances, and 8,000 B or deferred shares, credited as fully paid. The interests and rights of the vendors to the following patents are also taken over by the company for £1,500, to be deducted from one of the above-mentioned acceptances; viz.:—Dynamo-electric machine, No. 2,573, A.D. 1882; electric lamps, No. 4,017, A.D. 1881; electric lamps and electrodes, No. 2,560, A.D. 1882, granted to Mr. S. Hallett; sheathing or coating metal surfaces, A.D. 1881, No. 3,754 (half share), granted to Messrs. J. Jepson Atkinson and Wm. Elmore; obtaining, storing and utilizing gas for lighting and other purposes, No. 1,897, A.D. 1881 (half interest); galvanizing, No. 922, A.D. 1881, granted to Miss Julia Elmore; dynamo-electric machine, No. 3,567, A.D. 1879, and a dynamo-electric machine, No. 4,094, A.D. 1880, granted to Mr. Wm. Elmore; electro-turning, No. 2,491, dated 1881, granted to Mr. Wm. Elmore; copper extraction, No. 4,094, A.D. 1880 (two-thirds share), granted to Mr. Wm. Elmore.

Edison and Swan United Electric Light Company, Limited.—The registered office of this company is at 74, Coleman Street.

Insulite Company, Limited.—The registered office of this company is now situate at 50, Parliament Street, Westminster.

NEW PATENTS—1883.

5371. "Primary and secondary batteries for electric lighting and other purposes." J. NOAD and R. MATTHEWS. Dated November 14.

5400. "Telephone apparatus." M. KOTYRA. Dated November 15.

5408. "Magneto-electric and dynamo-electric machines." G. HOOKHAM. Dated November 16.

5417. "Primary voltaic batteries." D. G. FITZ-GERALD and T. J. JONES. Dated November 16.

5419. "Magnetic and electrical apparatus for the treatment of the nerves and muscles connected with the human eye and ear." S. MASON and C. R. HUXLEY. Dated November 16.

5422. "Dynamo-electric machines and electro-motors." Sir C. T. BRIGHT. Dated November 17.

5429. "Apparatus for lighting railway trains by electricity in combination with gas. E. EDWARDS. (Communicated by D. Tommasi.) Dated November 17.

5447. "Telephones." C. A. JACKSON. *Complete.* Dated November 19.

5448. "Telephonic or microphonic apparatus." H. H. LAKE. (Communicated by J. Berliner.) Dated November 19.

5453. "Housing and insulation of electrical wires beneath the surface of the ground." H. J. ALLISON. (Communicated by C. C. Gilman.) *Complete.* Dated November 20.

5465. "Meter for electric currents." A. M. CLARK. (Communicated by L. Hours-Humbert.) Dated November 20.

5469. "Secondary batteries or accumulators." F. MAXWELL LYTE. Dated November 20.

5470. "Dynamo-electric machines, which can also be used as electric motors." H. H. LAKE. (Communicated by T. J. McTighe and J. T. McConnell.) Dated November 20.

5471. "Telegraph and telephone lines, cables or conductors." H. H. LAKE. (Communicated by J. C. Chambers and N. C. Gridley.) Dated November 20.

5472. "Electric lamps or lighting apparatus." H. H. LAKE. (Communicated by T. J. McTighe and J. T. McConnell.) Dated November 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

648. "Adaption of the incandescent electric lamp to stage and other purposes." W. J. SAWARD and A. KOERBER. Dated February 6. 2d. Relates to a means and method of adapting a primary battery in connection with an incandescent electric lamp, for portable purposes, such as the stage, table lamp, locomotion, &c. For this purpose a band of chamois leather or other suitable material is used, and made to receive a required number of small primary batteries (so modified and improved as to be easily portable), the said band being fastened by means of a buckle in front, or made up as a ladies' dress improver; the cells then being placed in the folds, they are then joined up, and a small silk cord, containing the conductors, is then attached to the respective poles of the battery, and conveyed beneath the dress to the point at which the light is required. (*Provisional protection not allowed.*)

1452. "Apparatus employed in electric telephony." J. H. JOHNSON. (Communicated from J. A. Maloney, of America). Dated March 20. 6d. Relates to both the transmitting and the receiving instruments used in telephonic circuits. The improvement in the transmitting instruments is characterised mainly by the employment in a telephonic circuit of a condenser which is brought into action by the vibrations of the transmitter diaphragm in such manner that when the transmitter (which is in the line circuit) is in use the condenser will discharge intermittently to line with the effect of throwing on to the line a series of electrical impulses which are transmitted to the receiving end. The condenser is in a local charging circuit which is also completed through the transmitter. The transmitter consists of a wooden box, within which is a vertical thin wooden partition having an opening in it, which is covered by a diaphragm consisting of a thin sheet of metal applied to the front of the partition and secured thereto at its upper edge. The diaphragm is provided on its opposite faces or at front and back with a carbon tip or point—opposite to the carbon tip at front is a carbon point which is carried by an arm of spring metal pressed towards the diaphragm by an adjusting screw. In like manner the other carbon tip at back is carried by a spring metal arm which is pressed towards the diaphragm by an adjusting screw. The rear of the box is provided with a door, through which access can be had to the adjusting screw in rear of the diaphragm; and the box is provided with a hinged front door or false front (through which and the front wall of the box behind is formed the voice opening), by opening which false front access can be had to the front adjusting screw, whose head projects outwardly into a recess, formed in the front wall of the box. Upon the box are three binding posts—the centre one is in electrical connection with the diaphragm; one of the other posts is connected electrically to the front carbon tip; and the remaining post is electrically connected to the rear carbon tip. With a transmitter organised on this general plan are combined a battery, condenser and telephone receiver, the circuit connections being such that both the circuit through which the battery charges the condenser and the circuit through which the condenser discharges to line are completed through the transmitter.

1455. "Safety electric switch." C. J. WHARTON. Dated March 20. 2d. By means of a trigger spring and tumbler or spiral spring, to prevent the switch being left in any position except in perfect circuit or entirely broken circuit, whereby danger from heating, caused by arcing through imperfect contact, is rendered impossible. (*Provisional protection not allowed.*)

1472. "Propelling cars or other vehicles by electricity, &c." P. R. ALLEN. Dated March 20. 4d. Relates to improvements in the propulsion of cars and other vehicles on rail or tramways, or other places, and refers principally to those instances in which electro-motors are used for propelling the vehicles. (*Void by reason of the patentee having neglected to file a Specification, in pursuance of the conditions of the Letters Patent.*)

1475. "Voltaic batteries, &c." J. GRAY. Dated March 21. 2d. The electrodes of the batteries are zinc and carbon. They are separated by a porous cell. The liquid in which the zinc is immersed is a saturated solution of chloride of sodium or chloride of ammonium. The carbon is immersed in any one of the following three oxidising mixtures:—In the first, about one part of bichromate of potash is dissolved in six parts of sulphuric acid and one of water, to which is added one to two parts of nitric acid and five grains to the ounce of permanganate of potash. In the second mixture, about one part of bichromate of potash is dissolved in six parts of sulphuric acid and one of water, to which is added about two parts of nitrate of potash, or other equivalent nitrate, and five grains to the ounce of permanganate of potash. In the third mixture, one part of nitrate of potash, or other equivalent nitrate, is added to three parts of sulphuric acid. In this last case, by making a supersaturated hot solution of nitrate of potash, or other equivalent nitrate, a solid or semi-solid mixture is obtained on cooling. In all these three oxidising mixtures a constant current is obtained by using a much larger percentage of sulphuric acid than has hitherto been employed in such batteries. (*Void by reason of the patentee having neglected to file a Specification in pursuance of the conditions of the Letters Patent.*)

1518. "Manufacture of armatures for dynamo-electric machines." J. B. ROGERS and H. O'CONNOR. Dated March 22. 2d. Consists in manufacturing or constructing armatures of small pieces of iron (as filings, chippings, borings, wire lengths, or other forms in small particles), these being mixed or laid up in plaster of paris or other suitable substance as to make a solid mass instead of the existing means of using solid or hollow metal in the formation of such armatures. By the invention the magnetic force is increased and kept constant at all points instead of the magnetic field being merely contained in one pair of poles. (*Provisional only.*)

1538. "Electrical conductors or cables for telephonic purposes." H. H. LAKE. (Communicated from abroad by C. de Cazenave, of Belgium.) Dated March 24. 6d. Has for its object to obviate the induction between the wires. In some cases the inventor places an "anti-inductor" upon a telephonic post of a line of eight wires. This anti-inductor is composed of a metal band (preferably copper) of, say, four centimetres wide, one edge of which is directed towards the wires to facilitate the derivation of the current towards the earth; this derivation takes place by a wire, called a ground wire, placed at the lower part of the band, and leading into the earth along the post. To assist the derivation towards the earth, the edge directed to the wires can be cut or formed with teeth like a saw.

1541. "Electric batteries, &c." H. H. LAKE. (Communicated from abroad by Messieurs Radiguet et fils, of Paris.) Dated 26th March. 6d. Relates chiefly to electric batteries, and is designed to render them not liable to polarization, by the addition, to the positive element, of points for effecting the incessant liberation of gaseous bubbles produced by the decomposition of the water.

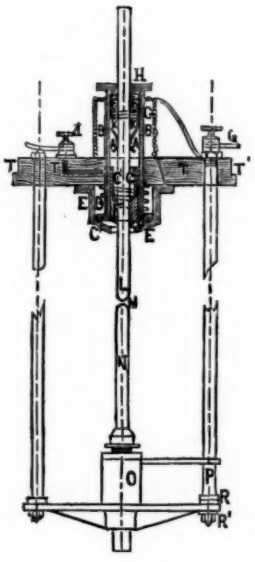
1556. "Electrical accumulators." H. E. NEWTON. (Communicated from abroad by D. Monnier, of Paris.) Dated March 27. 2d. Relates chiefly to the production of the plates to form an electrical accumulator by amalgamating two metals, one of which is afterwards eliminated. (*Provisional only.*)

1576. "Electro-magnetic printing telegraphs." W. P. THOMPSON. (Communication from H. Van Hoevenbergh, of America.) Dated March 28. 6d. The principal object of the invention is to secure increased rapidity of operation. To this end the type-wheel is caused to advance normally through consecutive arcs, each subtending three characters, or in other words so as to skip two characters at each step. When any one of the characters thus skipped is to be printed, the wheel is brought to rest upon an adjacent character thereto, and one or other of two devices is brought into action which mechanically imparts to the wheel a supplementary movement independently of its shaft, and in the required direction and extent to bring the desired character into

exact position. The impression is then taken therefrom. The invention further includes a form of automatic transmitting mechanism for operating the improved apparatus at the receiving station.

1618. "Electro-magnets." A. M. CLARK. (Communicated from abroad by L. C. A. J. G. d'Arlincourt. of Paris.) Dated March 30. 6d. Relates to the apparatus described Nov. 17th, 1883.

1623. "Electric arc lamps." F. M. NEWTON. Dated March 31. 6d. The figure is an elevation, partly in section, of an electric arc lamp according to the invention. A is an iron tube wound with a fine coil of insulated wire, B, which is so arranged as to form a shunt of high resistance around the arc. When it is traversed by a current the tube, A, becomes an electro-magnet. Below the tube, A, and in the same axial line, is a second tube, C, acting as an armature to the first. It is normally supported by the sheath or bracket, E, and is held away from the tube or magnet, A, by a helical spring, D. Within the tube, C, there is screwed or otherwise fixed another tube, C^1, of non-magnetic material, such as brass. It fits loosely within the electro-magnet, A, and serves, as a guide for the armature, C. Within the tube, A, and likewise within the tube, C, there are fixed a number of elastic metallic fingers or feelers, F, converging towards the axial line of the tubes, and inclined slightly in the direction in which the carbon is to travel. They are fixed in backing, which is bent into a cylindrical form, and secured from endwise motion in the tubes by collars or abutments, the upper feelers being held between the cap, H, and the internal collar, G^1, and the lower feelers between the tube, C^1, and the collar or contraction, G. The arc is struck by the electro-magnet, O, which draws down the negative carbon compressing a small spring within the body of the electro-magnet, which, when the lamp is extinguished by cutting off the current by any means, serves to raise the lower carbon through a distance greater than the length of the arc, and, therefore, into contact with the upper



carbon. so that the lamp can be relit by turning on the current without readjusting the carbons. One end of the coil of this magnet is in connection with the framing, and the other is connected by a wire to the right-hand standard, P, which is insulated at the bottom from the framing by the non-conducting washers, E, E^1, and at the top carries the negative terminal. The current enters the lamp at the positive terminal, I, and proceeds from thence along a permanent conductor to the tube, A. From that it is conveyed by the feelers, F, and also, when found necessary, as in lamps wherein large currents are employed, by the contact springs, K, K, to the carbon or electrode, L, down which it flows through the arc, M, to the negative carbon, N, and thence through the electro-magnet, O, to the rod, P, and negative terminal, Q. The shunt circuit branches off from the main circuit through the lower feelers, F, in the small piece of tube, C, and thence through the sheath, E, to the shunt coil, B, and from this to the negative terminal, Q. T, T is a piece of wood or insulating material to which the various parts of the lamp are attached. It is provided with a recess, T^1, T^1, to hold a light cover of thin sheet metal or other suitable material. When the current is first turned on the carbons are in contact, and the arc is instantly struck by the magnet, O. The carbons then gradually consume until the arc grows beyond the length for which the lamp is adjusted, a gradually increasing amount of current passing through the shunt coil until the electro-magnet, A, overpowers the spring, D, and attracts the armature, C, the feelers, F, sliding over the carbon. Immediately C rises the shunt circuit is broken between C and E, and the magnet, A, loses its power. The armature, C, then falls back under the influence of gravity and of the spring, D, carrying with it the carbon or electrode, L, as the feelers, F, will not slide over it in this direction, but obtain a frictional hold upon it after the manner of toggle levers. This alternate rising and falling action continues until the arc is reduced to its normal resistance, the carbon being drawn at each downward motion through the upper set of feelers, F, which prevent its being carried upwards by the friction of the lower set.

2205. "Dynamo machines and lamps connected therewith." SYDNEY PITT. (Communicated from abroad by L. Daft, of America.) Dated May 1. 6d. Relates to an improvement in dynamo machines and lamps connected therewith, especially applicable to forming arc lights, but the dynamo machine may be used for other purposes, and may be also used as a motor. The improvement in dynamo machines relates to a new and simple construction of armature by which the same may be readily and cheaply made, and it also relates to a method of concentrating the magnetic force of the field magnet immediately upon the wires from which the electricity is to be derived. The invention is applicable in many forms of winding.

2651. "Laying electrical conducting wires in the ground, and an insulating compound for electrical purposes generally." H. J. ALLISON. (Communicated from abroad by J. Greives and J. H. Bleoo, of America). Dated May 29. 6d. Relates to an improved system of laying electrical conducting wires in the ground; and it includes an improved conduit for such purpose, a device for discharging the induced electricity from the insulating coating of each wire, an improved manhole connecting with the conduit, and an improved insulating compound for use in laying the wires or in other situations. The improved conduit is formed by coating a metallic pipe internally with any insulating composition adapted to adhere permanently; the discharging device consists in a naked copper wire laid inside the conduit and connected at both ends or at intervals, with the ground or the exterior of the metallic conduit, and having the exterior insulated coating of each enclosed conductor electrically connected with it.

3000. "Electric arc lamps." S. PITT. (Communicated from abroad by N. H. Edgerton, of America). Dated June 16. 6d. Relates to a class of electric arc lamps in which the electrodes are in a vertical or nearly vertical position, in which the lower electrode is fixed and formed of refractory material, and in which the upper electrode is a carbon pencil so set as to rest during the time when it is not in contact with the fixed electrode, by its own weight, upon detaining pins of incombustible material which touch it a short distance to the rear of its extreme front end and arrest its gravitative action.

3001. "Dynamo-electric machines, &c." S. PITT. (Communicated from abroad by N. H. Edgerton, of America). Dated June 16. 8d. The object of the invention, broadly stated, is the construction of a bi-polar machine, from which one or a series of separate and distinct currents can be derived or produced, and to such end the invention, broadly considered, comprehends a system of coupling entirely distinct from any heretofore devised, and special constructions of the armature, commutator, and field magnets, enabling such coupling.

3007. "Insulators for electric wires, &c." L. B. GRAY. Dated June 16. 6d. Relates to improvements in insulators for electric-wires and means for connecting them to their supports, whereby the same may be applied and secured together in a very firm and expeditious manner.

3302. "Telephonic apparatus." W. R. LAKE. (Communicated from abroad by H. Clay, of America). Dated July 3. 6d. Relates to telephonic apparatus, and comprises improvements in call bells, transmitters, receivers, and switch boards.

5002. "Fittings for incandescent electric lamps." M. EVANS. Dated Oct. 20. 2d. The object of the invention is to provide ready means of mounting incandescent electric lamps on brackets, electroliers or other like supports, and of making at the same time the necessary connections. *(Provisional only).*

CORRESPONDENCE.

The Hammer Telephone.

If it is not encroaching too much upon your space, I should like to make a few more remarks upon the above subject, in reply to M. De Locht-Labye's letter of November 4th, 1883, and published in your issue of the 10th, in which he states that he does not consider the example quoted by me as suitable; but which, it is needless to state, I do, exhibiting as it does an example of the propagation of sound, not only in gases, but in liquids and solids also.

It is true, M. Ganot evidently did not deem it necessary to give a separate example of the application of the same law to these bodies. But it is nevertheless perfectly applicable, and is, I believe, generally admitted. All bodies possessing elasticity, their parts *are mobile in a greater or less degree*, therefore they *can* and *do undergo relative displacement*, although not to the same extent as do the particles of air.

As for the ivory billiard balls, I do not deny that

this experiment, with some modification, would represent the action in the telephone in question.

Let us suppose the last ball to be suspended in some viscous liquid, which offers a considerable resistance to its motion, or let it be pressed against the remaining ball by the action of a spring. If, now, the first ball be gently let fall the last would not detach itself, but would only vibrate to and fro in proportion to the elasticity of the intermediate balls.

In the case of the telephone, the hammer is the last ball, and the magnetic field the viscous liquid, or the mutual attraction of the magnet and the armature, the spring.

The words *free to move* perhaps require some slight qualification, by this I mean *that its movements are not tympanic*, but the whole lever bodily turns on the pivot.

Now for the molecular disturbance, the very existence of which M. Locht-Labye seems to doubt, but which, nevertheless, with its important bearing upon magnetism, Prof. Hughes abundantly demonstrated, in his highly interesting paper, read before the Society of Telegraph Engineers and Electricians on the 24th of May last, and I maintain that it is to these molecular movements that the reproduction of the overtones is due.

Lastly, I cannot bring myself to believe, without further evidence than as yet been brought forward, that intermittent currents, no matter in what manner produced, can possibly reproduce speech.

Trusting that M. Locht-Labye will forgive me for not being forced to recognise that there can be no other conclusion than that which he has formulated.

F. W. Cooke, A.S.T.E. & E.

Retford, *Nov. 19th*, 1883.

The Effects of Lightning.

Your correspondent, Mr. G. Thompson, may be excused the comicality of his communication by a plea of the infectiousness of Colonel Parnell's unconscious humour upon the same subject.

It may be questioned whether the head of a family hastily attaching a wire to the (probably hot) bars of the kitchen grate presents a more ridiculous picture than say, several hundred navvies prostrate in the mud to avoid the danger of being struck by lightning—the latter being a practical application of one of Colonel Parnell's suggestions, and given in all seriousness.

There may be persons who, divesting themselves of "metal pencil cases, keys, money, &c., prefer to betake themselves to the gutter during a thunderstorm, but the well advised will doubtless still prefer the shelter of a well protected house.

If Col. Parnell's opinions have met with few serious replies in your paper, it is doubtless due to the fact that useful discussion is exhausted, and years of experience have demonstrated the efficacy of properly applied lightning conductors.

Originality of idea may certainly be conceded the gallant Colonel, and no one will dispute his right to that simile wherein he describes "the *bolt* darting upwards like a *knife* to meet its eager partner (doubtless the fork) from the cloud."

It would certainly be no more out of place for an electrician to publish his view upon the culverin for use in modern warfare, or the advantages of the matchlock, than it is for Col. Parnell to advance his opinions at an equivalent stage of electrical knowledge.

If Col. Parnell had allowed sufficient safety valve area to his metaphorical boiler, he would have found a much closer resemblance to an efficient lightning conductor, and the steam bogey with which he conjures would have dispersed as harmlessly into air as its electric brother does into moist earth.

A certain class of the community think all boilers certain to burst, and they probably include among their number those who regard lightning conductors as storehouses of death, and (may be added) unloaded guns as liable to go off.

E. M. T.

"The Glasgow" or "English Mechanic" "Receiver."

Can you do me the favour of saying wherein the above kind of telephone receiver, manufactured and used by the Globe Telephone Company, is clear of the Bell patent? As fixed in subscriber's offices, it appears to be essentially a Bell; but if it be not an infringement, is there anything to prevent other parties from manufacturing and selling such receivers? Has our authoritative friend, Mr. Barney, or the United Telephone Company's electrician had a look at these instruments and can they be pronounced clear?

D.

[We cannot express any opinion on this matter.—EDS. ELEC. REV.]

The Utilization of the Forces of Nature.

In your editorial of November 10th, and in your correspondence columns, the question of the utilization of the forces of nature has been commented upon, especially the storage of power by lifting heavy weights to the required height. I wish to make a few remarks upon the impracticability of this scheme.

Take as an example the storage of 10 H.P. for six hours, which, for practical purposes, would be considered as a very small amount. This represents about 53,000 foot tons, and if we take as an exceptional case an existing pit, or cliff (for which no doubt this method of storage was suggested in your article), a fall of, say, 530 feet, the weight must be equal to 100 tons. Of course I shall not reckon here any loss of power through pulleys, gearing, &c., either in the act of storing or in the return.

If we take the most compact form of weight as lead, the actual price for our weight alone will be about £1,000. Pig iron would cost about £250 for the same weight. If we take the cheapest form of weight as stone or granite, the bulk is too enormous to entertain practically. Granite (broken), for instance, would have a bulk of 100 cubic yards about, and besides, the receptacles for carrying such a weight will be much more expensive than if we use pig iron or lead, as we must employ in the case of the stone a large number of carriers.

The price of the ropes, chains, or other appliances, would also be excessive.

I think I am right in the supposition that £1,000 would not cover the outlay in the case of pig iron or stone, and as regards lead the cost, of course, would be much more. I do not take into account any percentage for depreciation of plant, &c. It will be more economical to employ water pumped from a low to a high level, at the sea-side for instance, or to compress air; but what I really would advocate is the accumulation of power by means of electro-decomposition, as in the secondary battery. If we take the Faure accumulator, which is capable of storing about 11 H.P. for one hour per ton of material (see Prof. Osborne Reynolds' Cantor Lecture on the transmission of power), we shall require, say, six tons of accumulators to produce the same result as that given by our falling weight. In the more recent form of accumulators, I think the storage capacity is as much as 35 to 40 H.P.-hour per ton. But this still can be improved upon, as it is far below the theoretical limit, which Prof. Reynolds puts as high as 190 H.P.-hours per ton of material. If, instead of lead, we use zinc in some suitable manner, we can obtain for the consumption of one pound of this metal 1,845,000 foot pounds, or nearly 1 H.P.-hour. So, if we have an arrangement in which can be decomposed any salt or oxide of zinc, we shall require, for our example, only 65 lbs., or thereabouts, of zinc to be deposited from the said salt or oxide. Of course, in place of zinc we could store energy by the decomposition of salts or oxides of hydrogen, potassium, sodium, calcium, &c. Then the accumulative capacity will be still higher, and we shall require a less amount of material to do the same work.

John Rapieff.